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## TWO NEW SPECIES OF *LIZZIA* (HYDROZOA: ANTHOMEDUSAE) FROM THE EASTERN TROPICAL PACIFIC

Lourdes Segura

**Abstract.**—Two new planktonic species of hydromedusae from the Eastern Tropical Pacific, *Lizzia alvarinoae* and *Lizzia ferrarii*, are described and compared with the 5 other species of *Lizzia*, *L. blondina*, *L. elizabethae*, *L. fulgurans*, *L. gracilis*, and *L. octostyla*. Morphological differences, as well as differences in the number and characteristics of the oral tentacles, are detailed.

**Resumen.**—Se describen dos especies nuevas de hidromedusas del plancton del Pacífico Tropical Oriental, *Lizzia alvarinoae* y *Lizzia ferrarii* y se comparan con las otras especies del género, *L. blondina*, *L. elizabethae*, *L. fulgurans*, *L. gracilis* y *L. octostyla* de las cuáles se diferencian en la morfología, así como en el número y características de los tentáculos orales.

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Two new anthomedusas were found in the plankton collected on the series of cooperative cruises made during the EASTROPAC expedition between February 1967 and April 1968. A vast expanse of the Eastern Tropical Pacific was surveyed on EASTROPAC, extending from 20°N to 20°S, and from the American coasts offshore to 126°W. The plankton collections were taken in oblique plankton hauls with a plankton net (0.5 m mouth opening) made of 333  $\mu$ m Nitex cloth. The collections were taken from different depths to the surface in the epiplankton region. All drawings in this work were made freehand from preserved material. Type-material of both species is deposited in the National Museum of Natural History, Smithsonian Institution (USNM).

### *Lizzia alvarinoae*, new species

Figs. 1-2

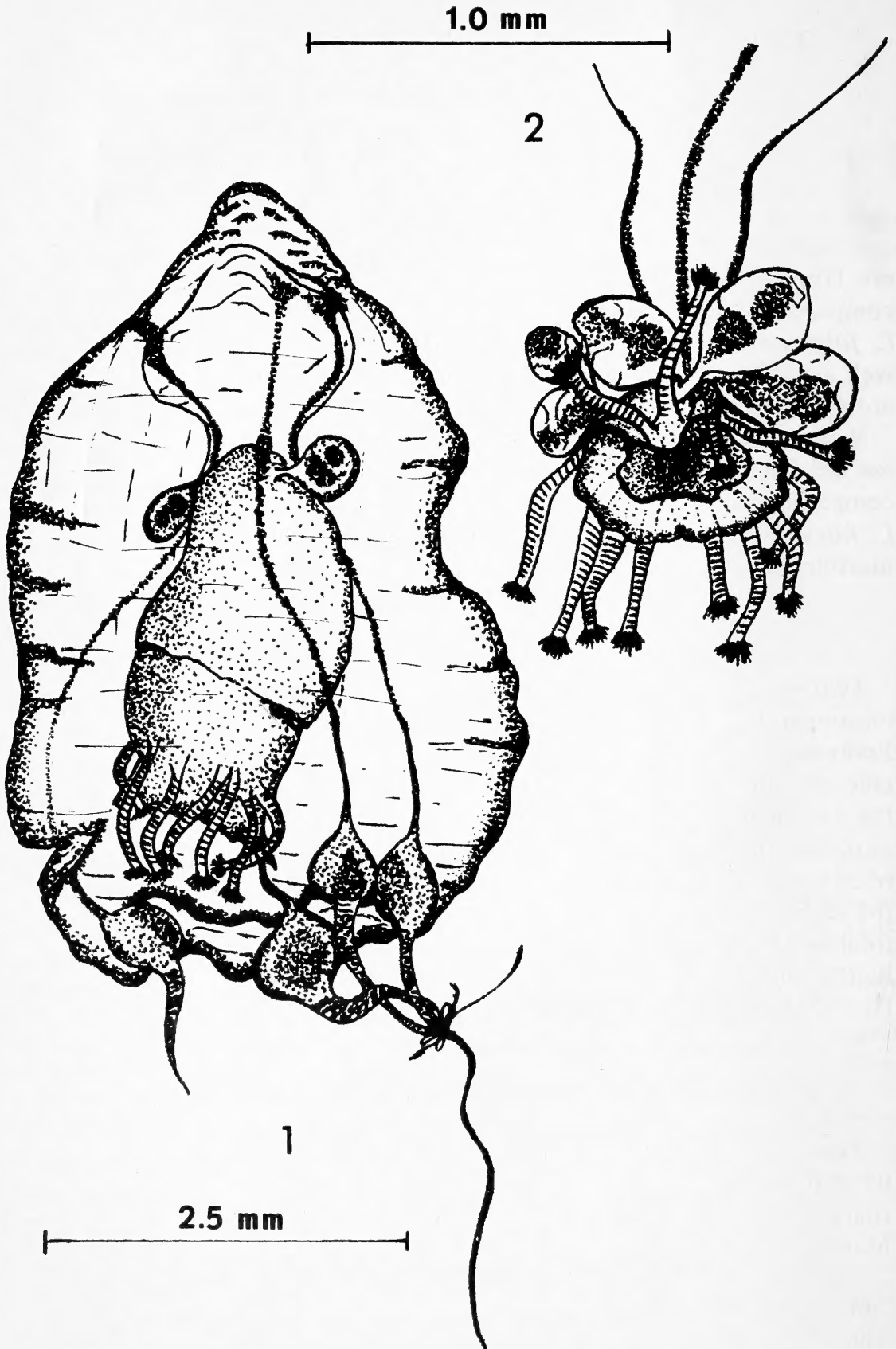
**Type-material.**—Holotype, USNM 59270, collected 23 March 1968, 03°19.0'S; 098°05.0'W, surface; 2 paratypes: USNM 58932, collected 19 February 1968, 02°49.0'S, 084°57.0'W, 0-209 m; USNM 58933, collected 7 March 1968, 02°31.5'S, 105°03.5'W, 0-209 m.

### **Additional material.**

Sta. 13.159; 10°46'S, 098°00'W; 26-II-1967; 204-0 m; 3 specimens

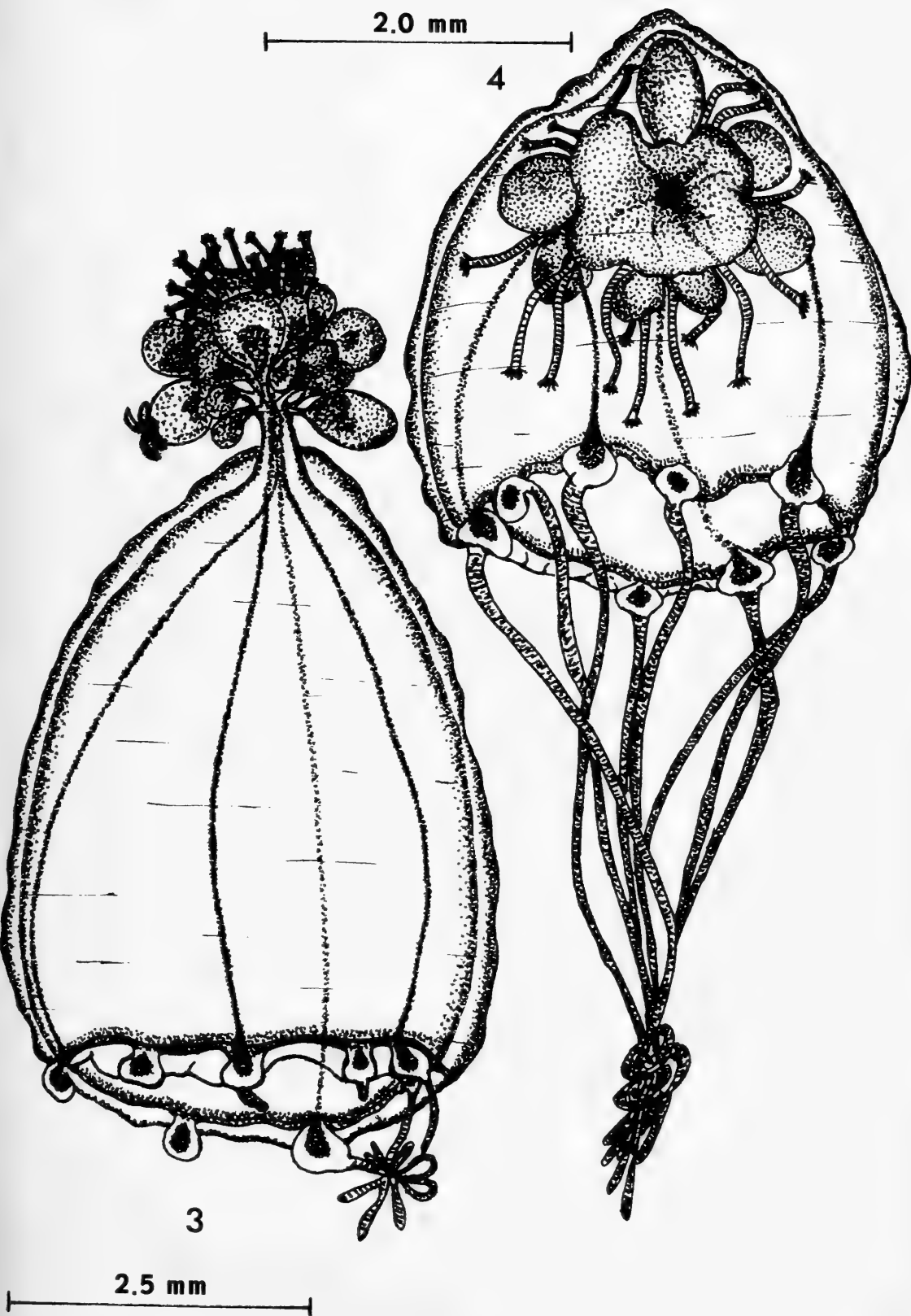
Sta. 20.256; 12°45'N, 098°22'W; 22-V-1967; 214-0 m; 1 specimen

Sta. 76.076; 04°42'S, 104°58'W; 8-III-1968; 213-0 m; 2 specimens



Figs. 1-2. *Lizzia alvarinoae*: 1, Drawn from preserved adult specimen showing shape of the umbrella and the 4 marginal tentacles; 2, Stomach and peduncle, showing insertion of oral tentacles above buccal margin and arrangement and shape of medusa buds.





Figs. 3–4. *Lizzia ferrarii*: 3, Detail of umbrella and stomach, showing different developmental stages of medusa buds, one with 4 short marginal tentacles; 4, Drawn from preserved adult specimen, showing mouthparts and size and shape of marginal tentacles.

Sta. 76.088; 10°53'S, 104°58'W; 10-III-1968; 210–0 m; 1 specimen

Sta. 77.144; 14°59'S, 084°56'W; 15-II-1968; 202–0 m; 1 specimen

Sta. 77.159; 10°50'S, 085°02'W; 16-II-1968; 198–0 m; 1 specimen

Sta. 77.438; 15°00'S, 088°09'W; 8-IV-1968; 212–0 m; 1 specimen

Sta. 77.452; 15°00'S, 093°06'W; 9-IV-1968; 194–0 m; 1 specimen

*Diagnosis*.—Hydromedusae with 4–20 unbranched oral tentacles; 4 radial marginal tentacles, and oval-shaped medusa buds on stomach walls.

*Description*.—Bell of holotype 2.5 mm high, 2.0 mm in diameter. Umbrella about 1.0–1.5 mm high and 1.5–2.0 mm wide, dome-shaped, usually slightly higher than wide, with small apical projection (Fig. 1). Jelly moderately thick, especially in apical region. Stomach large, barrel-shaped, attached to a broad-based conical peduncle. Medusa buds oval-shaped, stalked, located on interradial regions of stomach walls. Mouth simple with round opening, surrounded by 4–20 unbranched oral tentacles arising above mouth margin, each with 1 terminal nematocyst cluster (Fig. 2). Stomach and mouthparts extend together beyond half the length of the bell cavity. Four radial marginal tentacles, all of one kind, arise from bell margin. Basal tentacle bulbs large, pear-shaped, with endoderm deeply pigmented. It was not possible to determine the velum dimensions.

*Remarks*.—The species of *Lizzia* can be rather easily confused with *Podocoryne* or *Rathkea* in some stages of development (Russell, 1954). However, the latter genera can be distinguished by the form of the mouth-lips which are expansions of the lips, each having a single cluster of nematocysts. In *Lizzia* the oral tentacles are inserted a short distance above the opening of the mouth, and each has one terminal nematocyst cluster.

The genus *Lizzia* was established by Forbes in 1846, and there are 5 species described at present. The major differences among them are summarized in Table 1. *Lizzia alvarinoae* differs from the other species mainly in two morphological characteristics. There are only 4 marginal tentacles, all radial, and the number of oral tentacles varies between 4–20. In other species the marginal tentacles are more than 4 and the oral tentacles do not number more than 8.

*Etymology*.—Named in recognition of the prolific contributions of Dr. Angeles Alvarino in the field of Marine Biology.

*Lizzia ferrarii*, new species

Figs. 3–4

*Type-material*.—Holotype, USNM 58929, collected 13 April 1968, 04°56.0'S, 095°13.0'W, surface; 2 paratypes: USNM 58930, collected 18 February 1968, 05°41.0'S, 085°03.0'W, 0–220 m; USNM 58931, collected 8 March 1968, 04°42.0'S, 104°58.0'W, 0–213 m.

*Additional material*.

Sta. 13.071; 04°16'S, 092°05'W; 15-II-1967; 206–0 m; 1 specimen  
 Sta. 13.322; 11°47'N, 095°08'W; 18-III-1967; 213–0 m; 2 specimens  
 Sta. 14.138; 07°55'S, 088°46'W; 1-III-1967; 214–0 m; 1 specimen  
 Sta. 14.255; 04°03'S, 086°17'W; 22-III-1967; 207–0 m; 8 specimens  
 Sta. 14.287; 09°56'S, 083°56'W; 26-III-1967; 210–0 m; 1 specimen  
 Sta. 45.365; 18°48'N, 104°44'W; 10-IX-1967; 207–0 m; 4 specimens  
 Sta. 46.050; 02°50'N, 105°16'W; 23-VIII-1967; 204–0 m; 1 specimen  
 Sta. 46.137; 11°48'N, 092°02'W; 15-IX-1967; 206–0 m; 2 specimens  
 Sta. 46.147; 08°28'N, 092°05'W; 17-IX-1967; 170–0 m; 1 specimen  
 Sta. 46.155; 05°40'N, 091°58'W; 18-IX-1967; 224–0 m; 1 specimen  
 Sta. 47.049; 01°00'N, 082°00'W; 5-VIII-1967; 215–0 m; 1 specimen  
 Sta. 75.239; 05°00'N, 098°02'W; 4-IV-1968; 211–0 m; 1 specimen  
 Sta. 77.177; 05°41'S, 085°03'W; 18-II-1968; 220–0 m; 1 specimen  
 Sta. 77.386; 02°40'S, 088°04'W; 4-IV-1968; 206–0 m; 1 specimen  
 Sta. 77.394; 04°01'S, 088°00'W; 4-IV-1968; 238–0 m; 2 specimens  
 Sta. 77.420; 10°22'S, 087°57'W; 6-IV-1968; 215–0 m; 1 specimen  
 Sta. 77.452; 15°00'S, 093°06'W; 9-IV-1968; 194–0 m; 1 specimen  
 Sta. 77.482; 07°29'S, 094°57'W; 12-IV-1968; 201–0 m; 1 specimen  
 Sta. 77.491; 04°56'S, 095°13'W; 13-IV-1968; 217–0 m; 26 specimens

*Diagnosis.*—Hydromedusae with 12–24 unbranched oral tentacles; 8 long marginal tentacles, 4 radial and 4 interradial in position, and pear-shaped medusa buds developed on stomach walls.

*Description.*—Bell of holotype 2 mm high, 2 mm in diameter. Umbrella about 1.0–2.5 mm high and 1.0–3.0 mm wide, dome-shaped, sometimes a little wider than high, with a small apical projection. Jelly very thick, especially in apical region. Velum broad. Stomach cylindrical, attached to a small conical peduncle. Medusa buds completely surrounding stomach, pear-shaped, differing morphologically in different stages of development. Some have only 4 short, equally developed, marginal tentacles (Fig. 3). Mouth a simple round opening, surrounded by 12–24 unbranched, oral tentacles arising above mouth margin, each with 1 terminal nematocyst cluster. Stomach and mouthparts together extend beyond half the length of the bell cavity. The 4 radial canals and ring canal narrow; with 8 long, similar, marginal tentacles, 4 radial and 4 interradial (Fig. 4). Tentacles  $\frac{1}{3}$  longer than bell height. Basal tentacle bulbs large, pear-shaped. Each tentacle bulb with a dense mass of red endodermal pigment, which in radial tentacle bulbs extends a short distance up radial canals.

*Remarks.*—*Lizzia ferrarii* differs from the related species in two morphological features. The number of oral tentacles, which in other species is no greater than 20, varies between 12–24. *L. ferrarii* has 8 marginal tentacles. All related species except *L. gracilis* have different numbers. However the tentacles of *L. gracilis* are small and curve upwards over the margin of the umbrella; the radial tentacles are twice as long as the interradial ones. In *L.*

Table 1.—Differential characteristics of species of *Lizzia*.

Characteristics	Species			
	<i>L. blondina</i> Forbes, 1848	<i>L. elizabethae</i> Haeckel, 1879	<i>L. fulgurans</i> (Agassiz, 1865)	<i>L. gracilis</i> (Mayer, 1910)
Umbrella	Semiglobular 2 mm high and wide Thick apice Velum broad	Pear-shaped 6 mm high and 4 mm wide Thick apice	Pear-shaped 1 mm high Velum broad	Broader than high (3 mm). Slight apical projection Velum broad
Gastric peduncle	Low, pyramidal	Short	Well developed	Slightly developed
Stomach	Short, quadrangular	Along with the peduncle reaches as far as half the bell cavity	Short	Short
Oral tentacles	4 Small, simple unbranched	4 Radial, as long as the stomach	4 Simple, unbranched	8 4 radial and 4 interradial
Medusa buds	On the stomach	Not frequently observed	On the stomach	On the stomach
Marginal bulbs and tentacles	8 4 radial with 3 tentacles each 4 interradial with 1 tentacle each	8 4 radial with 4 tentacles each 4 interradial with 2 tentacles each	8 sometimes 16 Each with 1 stiff and upward curved tentacle	8 4 radial and 4 interradial each with 1 stiff and upward curved tentacle
Geographic distribution	North-western Europe; Portugal; Mediterranean	English Channel, England	North Carolina, New England	Tortugas, Florida; Sunda Strait, Indonesia



Table 1.—Continued.

Characteristics	Species		
	<i>L. octostyla</i> (Haeckel, 1879)	<i>L. alvarinoae</i> n. sp.	<i>L. ferrarii</i> n. sp.
Umbrella	0.4 mm high 0.5 mm wide Low conical projection	Dome-shaped, slightly higher than wide Short apical projection	Dome-shaped, wider than high. Jelly thick in apical region Velum broad
Gastric peduncle	Well developed	Large, with broad base	Small, conical
Stomach	Same length as the peduncle	Large, barrel-shaped	Cylindrical
Oral tentacles	8 Situating in pairs on the four radii	4–20 Simple, unbranched	12–24 Simple, unbranched
Medusa buds	On the stomach	Oval-shaped, on the stomach	Pear-shaped, on the stomach
Marginal bulbs and tentacles	8 Small, each with 1 tentacle, sometimes with an additional tentacle on each radial bulb	4 Large and pear-shaped, radial, each with 1 tentacle	8 4 radial and 4 interradial, each with 1 long tentacle
Geographic distribution	Adriatic Sea	Eastern Tropical Pacific	Eastern Tropical Pacific

*ferrarii* the marginal tentacles are large, equal in length and without any curvature.

*Etymology*.—*Lizzia ferrarii* is named after Dr. Frank D. Ferrari who kindly placed at my disposal the plankton collections of the EASTROPAC expedition.

### Acknowledgments

I wish to express my appreciation to Dr. Frank Ferrari, Director of the Oceanographic Sorting Center, Smithsonian Institution for the reasons cited above. I am especially grateful to Dr. Angeles Alvariño for checking the descriptions of these two new species and reviewing the manuscript.

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## ORATOSQUILLA MEGALOPS, A NEW STOMATOPOD CRUSTACEAN FROM TAIWAN

Raymond B. Manning

*Abstract.*—This new species is distinguished from *O. sollicitans* Manning, 1978, by its unusually large eyes.

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In a recent review (Manning, 1978) of some species of the Indo-West Pacific stomatopod genus *Oratosquilla*, I pointed out the apparent variability in material assigned to *O. sollicitans*, and noted (p. 28) that three specimens from Anping, Taiwan probably represented a distinct species. Through the kindness of L. Tiefenbacher, Zoologisches Staatssammlung, Munich, I was able to reexamine these specimens to verify that their eyes are noticeably larger than those of other specimens assigned to *O. sollicitans*. These three specimens are assigned to a new species herein.

I thank L. Tiefenbacher for the loan of the material and my wife Lilly for preparing the illustrations.

### *Oratosquilla megalops*, new species

Fig. 1

*Material.*—Anping [An-P'ing or Ampin, 23°00'N, 120°09'E], S Taiwan; Haberer, leg.; June 1905: 3 ♂, total lengths 63 to 69 mm (largest male is holotype, smaller males are paratypes; all specimens in Zoologisches Staatssammlung, Munich).

*Diagnosis.*—As in *O. sollicitans* Manning, 1978:25, fig. 13, except: Rostral plate (Fig. 1a, e, f) slightly broader than long, appearing elongate, tapering anteriorly to convex anterior margin. Eye (Fig. 1b) moderate to large, corneal indices 290–313 in specimens less than 70 mm long. Lobe between basal prolongation of uropod (Fig. 1d) small, rounded, narrower than adjacent spine.

*Name.*—The specific epithet is from the Latin and refers to the enlarged eyes.

*Remarks.*—The eyes of *O. megalops* (Fig. 1b) resemble those of *O. sollicitans* in shape but not in size. The corneal indices of *O. megalops*, 290–313, do not overlap those of *O. sollicitans* of similar size, 340–400 (see Manning, 1978, table 1 on p. 42). The eyes of *O. megalops* also appear to be larger than those of the similar *O. hindustanica* Manning, 1978, from India. Only one of 27 specimens of the latter species, the smallest male

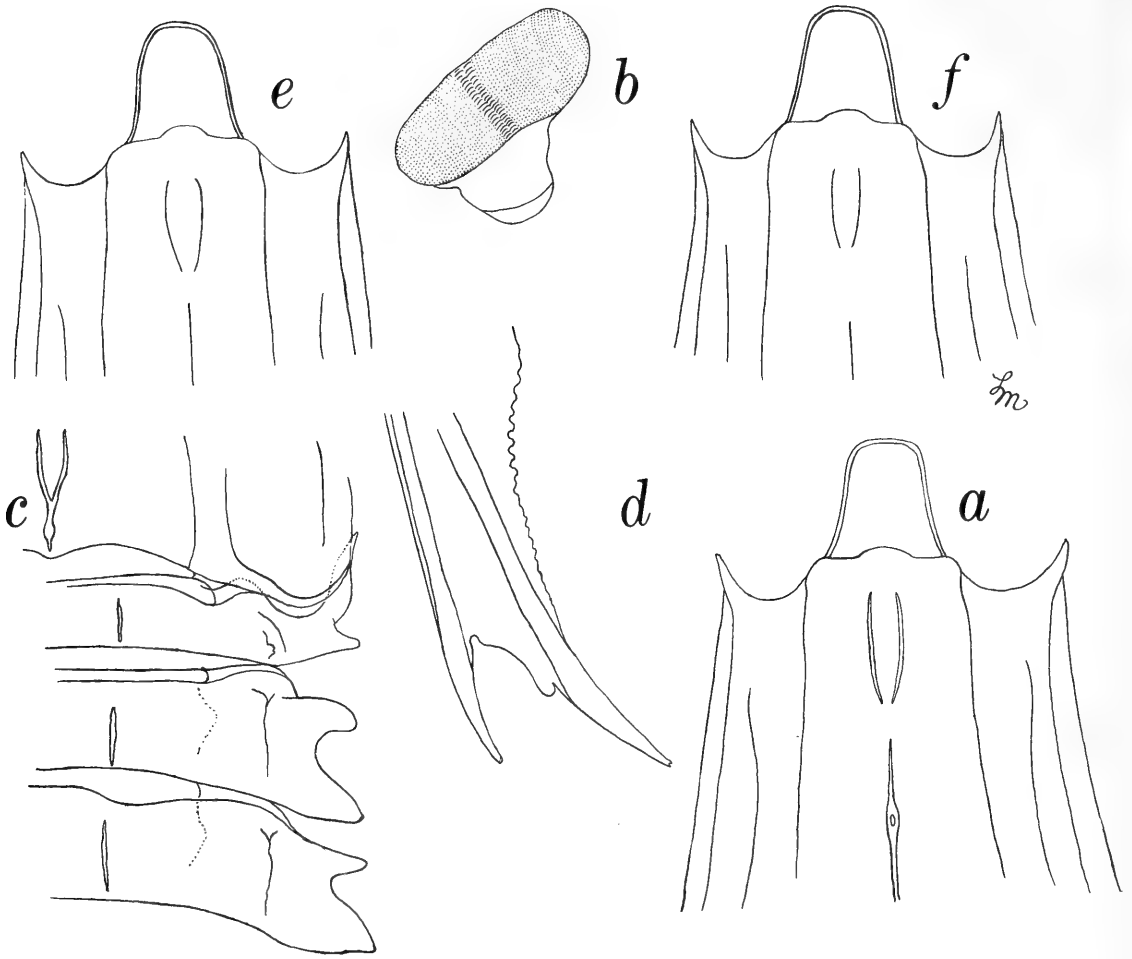


Fig. 1. *Oratosquilla megalops*, male holotype, 69 mm: **a**, Anterior part of carapace; **b**, Eye; **c**, Lateral processes of exposed thoracic somites; **d**, Basal prolongation of uropod. Anterior part of carapace of: **e**, Male paratype, 63 mm; **f**, Smallest male paratype, carapace length 12.2 mm.

examined, 47 mm long, had a similar corneal index, 309. Specimens of *O. hindustanica* 60 to 70 mm long had corneal indices ranging from 338 to 373.

The present material strongly suggests that each of the morphological forms recognized in *O. sollicitans* (see Manning, 1978:26–28, fig. 15a–d) probably represents a distinct species.

#### Literature Cited

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## REAPPRAISAL OF THE GASTROPOD GENUS *VARICOPEZA* GRÜNDEL (CERITHIIDAE: PROSOBRANCHIA)

Richard S. Houbbrick

*Abstract.*—The genus *Varicopeza* is described and its relationship to the genera *Bittium* and *Argyropeza* is established. This monotypic genus, represented by *Varicopeza pauxilla* (A. Adams), is found in deep sea environments throughout the Indo-West Pacific. A synonymy and new description which includes radular features and aspects of soft anatomy, and an historical review of the literature are presented. The ecology of the species and the functional significance of the shell aperture are discussed.

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Numerous lots of a small, *Bittium*-like cerithid dredged by the R.V. *Albatross* in the Philippine archipelago and deposited in the National Museum of Natural History, Smithsonian Institution have prompted this review. This small cerithid belongs to the monotypic genus *Varicopeza* Gründel, 1976 and has long been overlooked or misidentified in most museum collections where it is frequently found mixed with other small cerithid species. Closely related to the genera *Argyropeza* and *Bittium*, *Varicopeza pauxilla* (A. Adams) has a long synonymic history and has been largely ignored in the literature, except when mentioned incidentally.

In this review, I have examined material from the major American and Australian museums and several other institutions. The sparse anatomical material available for study was poorly preserved. I have surveyed the literature as completely as possible. Whenever possible, types of all nominal species were examined. Scanning electron micrographs were made of the radula, shell and operculum and preserved specimens examined for gross anatomy.

The following abbreviations appear in the text: AMS, Australian Museum, Sydney; ANSP, Academy of Natural Sciences of Philadelphia; BM, Berlin Museum; BM(NH) British Museum (Natural History); NMV, National Museum, Victoria; TAU, Tel-Aviv University; USBF, United States Bureau of Fisheries; USNM, United States National Museum of Natural History; WAM, Western Australian Museum.

Family Cerithiidae Fleming, 1828  
Genus *Varicopeza* Gründel

*Varicopeza* Gründel, 1976:46, plate 1, figures 11-13. Type-species: by tau-

tonomy, *Varicopeza varicopeza* Gründel, 1976 [= *Varicopeza pauxilla* (A. Adams, 1854)].

*Description*.—Small, slender turreted shell characterized by flat-sided whorls, deeply impressed suture and overall sculpture of spirally beaded bands and axial riblets. Body whorl wide with distinctive thick varix opposite outer lip. Aperture wide with flaring outer lip and wide, deeply impressed, anterior, inhalant, siphonal canal; wide, spoutlike, posterior exhalant canal in upper outer lip directly opposite anterior siphonal canal. Protoconch smooth with convex whorls. Operculum ovate, paucispiral and with subcentral nucleus. Radular ribbon taenioglossate (2+1+1+1+2) with thin, sicklelike lateral teeth and marginal teeth serrated with tiny denticles. Rachidian tooth with long, spadelike, basal plate, two tiny, basal denticles and a long central tooth.

*Etymology*.—Varix-foot, from the Latin, *varix*, “dilation” or “varix” and *pes*, “foot.” *Varicopeza* is a feminine Latin noun.

*Remarks*.—This monotypic genus is widely distributed throughout the Indo-West Pacific geographic province where it is confined to the continental shelf and slope. The animal, shell, opercular and radular characters all indicate a close relationship to the genera *Bittium* Gray, 1847, and *Argyropeza* Melvill and Standen, 1901. The spoutlike exhalant siphonal canal in the upper part of the outer lip of the type-species (see Fig. 1 a–e, j) is so different from anything seen in *Bittium* or *Argyropeza* species that I believe recognition of the genus *Varicopeza* Gründel, 1976 to accommodate the species is justified, both on morphological and functional grounds.

The genus *Varicopeza* is not known from the fossil record. On the basis of shell sculpture, Gründel (1976) believed the genera *Varicopeza* and *Argyropeza* Melvill and Standen, 1901 to be Recent representatives of the family Procerithiidae Cossmann, 1905, subfamily Cryptaulinae Gründel, 1976, and placed *Bittium* in the same family. I find Gründel’s classification too dependent on unimportant shell characters and topheavy with supra-specific taxa; consequently, I prefer to regard *Varicopeza* as a genus in the Cerithiidae until there is more solid information upon which to base supraspecific categories.

*Varicopeza pauxilla* (A. Adams, 1854)

Figs. 1–2

*Cerithidea* (*Pirenella*) *pauxilla* A. Adams, 1854:86 (Holotype: BM(NH), not registered; Type-locality: Burias, Philippines).

*Cerithium pauxillum* (A. Adams). Sowerby, 1855:889–890, pl. 186, fig. 294 (*non* Pease, 1860); Reeve, 1865, pl. 20, fig. 144; Tryon, 1887:141, pl. 34, fig. 95; Kobelt in Martini Chemnitz, 1898:228, pl. 40, fig. 8; Schepman, 1909:162; Oostingh, 1925:45.



*Cerithium bicanaliferum* Brazier, 1877:317 (Lectotype: AMS A-72, here selected; 7 paralectotypes; Type-locality: 30 fathoms, Darnley Id., Torres Straits, Queensland, Australia); Hedley, 1901:127, pl. 17, fig. 25; Ponder, 1972:45.

*Cerithium trigonostomum* Melvill, 1910:10, pl. 1, fig. 15 (Lectotype: BM(NH), not registered, largest from F. W. Townsend Collection, here selected; 3 paralectotypes, two with Reg. No. 1912.8.16.97-8: Type-locality: 40 fathoms, Merkan Coast, Charbar [Pakistan]).

*Argyropeza involuta* Thiele, 1918:120, pl. 21, figs. 20, 20a (Holotype: BM, not registered; Type-locality: sta. 245, 5°27.9', 39°18.8'E at 463 meters (near Zanzibar)).

*Varicopeza varicopeza* Gründel, 1976:46–48, figs. 8, 11, 12, 13 (Holotype: BM, not registered; Type-locality: 0°30'S, 107°5'W, South China Sea).

**Description.**—*Shell* (Fig. 1 a–e, g–j): Shell small, about 7 mm long, 2.2 mm wide, thin, slightly transparent, slender and turreted, having apical angle of 24 degrees and white to light tan in color. Teleoconch comprises 8–13 straight-sided whorls that angle sharply inwards on each side at the deeply impressed suture to form distinct sutural ramps. Each whorl sculptured with raised spiral cords and broader, less distinct axial riblets. Where cords cross ribs, small, sharp beads appear, giving an overall spiny appearance. Early whorls of teleoconch have only 2 spiral cords; mid-whorls and penultimate whorl each with 3 dominant spiral cords and one weaker spiral cord on the upper and lower sutural ramp. Protoconch of 3.5 concave, smooth whorls the last 2 of which are sculptured with a centrally located microscopic spiral thread. Lip of protoconch sinuous, thickened into spout-like exhalant siphon at upper surface. Body whorl broad, with wide, prominent varix opposite outer lip. Sculpture of body whorl comprises 4 raised, primary spiral cords. Between each of these, is a thinner, raised spiral cord. Base of body whorl constricted at siphonal area and sculptured with 6–7 thin, raised spiral cords. Outer lip crenulate, flaring and thickened on outside, due to lip varix. Aperture triangular-ovate with concave, smooth columella and wide, anterior inhalant siphonal canal that is turned to the left 45 degrees to shell axis. A prominent posterior exhalant siphonal canal is formed by spoutlike notch in upper, outer lip directly opposite to, and in line with, anterior siphonal canal.

**Operculum:** (Fig. 1f) Operculum corneous, thin, ovate and paucispiral with a subcentral nucleus. Operculum fits aperture snugly when animal is retracted into shell, and has a very thin, flexible border.

**Radula:** (Fig. 2) Radular ribbon taenioglossate, tiny, about one-ninth the length of the shell, and comprising about 20 rows of teeth. Rachidian tooth shield-shaped with spadelike basal plate upon which are 2 thickened, but small basal cusps. Top of rachidian tooth straight with long, pointed, central

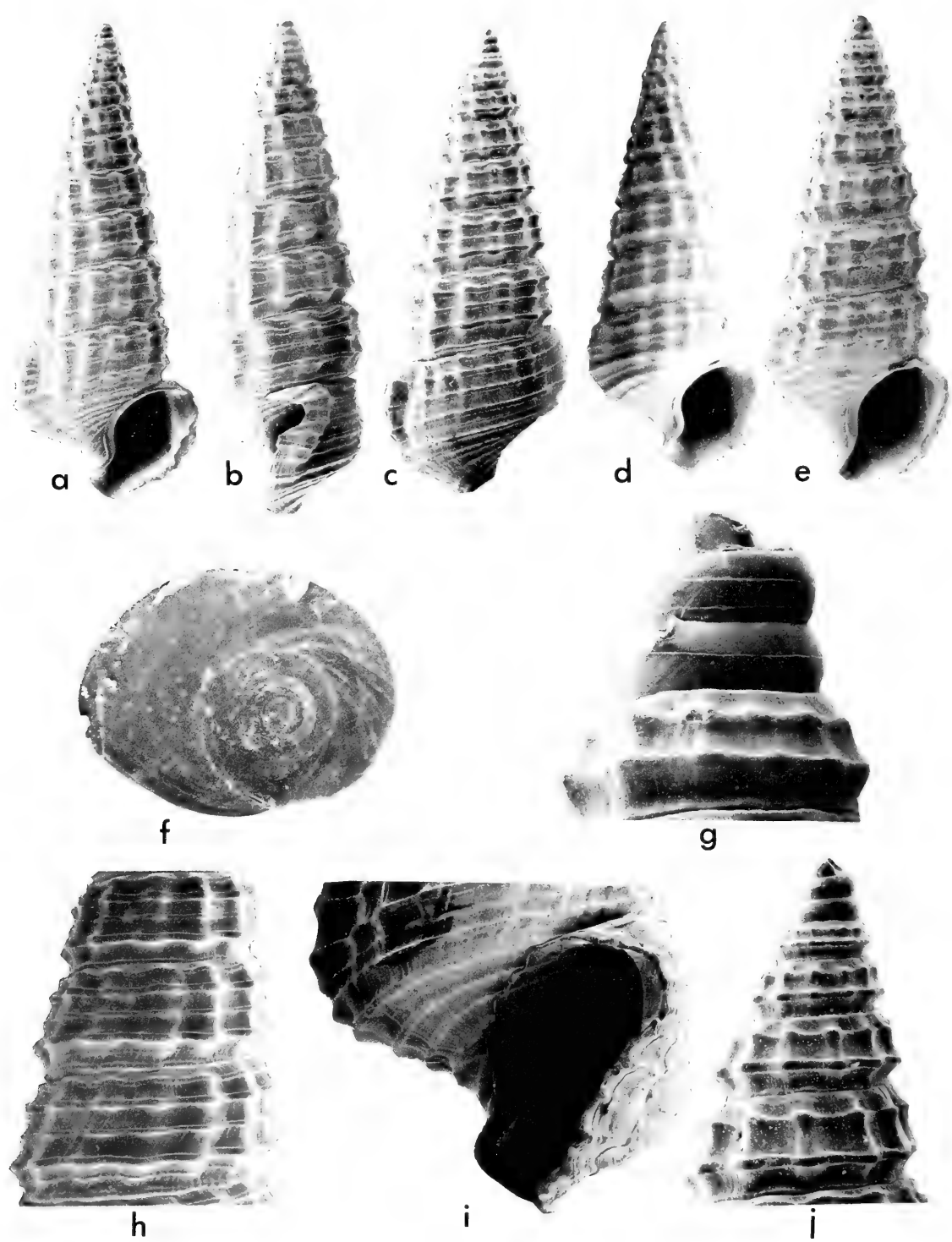


Fig. 1. *Varicopeza pauxilla*, scanning electron micrographs showing shell physiognomy and operculum. a–d, Apertural, side, dorsal and apertural views of adult shells, all USBF Station 5435, 80 meters, soft mud, off Nagubat Id., E. Mindanao, Philippines (USNM 276898), 30×; e, Adult shell, 52 meters off Mersat Abu Samra, Gulf of Aqaba, Israel (USNM unaccessioned) 30×; f, Operculum of specimen from USBF Station 5426, 49 meters, off Mantaquin Id., E. Palawan, Philippines (USNM 288300), 75×; g, Enlargement of protoconch showing sculptural details and spoutlike notch in protoconch lip, 75× same data as in a–d; h, Detail of sculpture



Fig. 2. Scanning electron micrographs of radula of *Varicopeza pauxilla*. **a**, Radular ribbon with some marginal teeth folded back to expose lateral teeth, 500 $\times$ ; **b**, Enlargement of rachidian and lateral teeth, 1,000 $\times$ ; **c-d**, Marginal teeth showing cusp placement on inner and outer marginals, 600 $\times$ , 1,000 $\times$ .

←

on penultimate and adult whorls, 55 $\times$ , same data as a-d; **i**, Close-up of aperture showing exhalant siphonal canal, 200 $\times$ , same data as a-d; **j**, Detail of early whorls of teleoconch, 55 $\times$ , same data as a-d.

tooth flanked by 3–4 small denticles on each side. Lateral tooth rhomboid with straight top, serrated with one inner sharp denticle, a larger, triangular pointed tooth, and with 6–7 smaller pointed denticles. Basal plate of lateral tooth smooth, flat, with long, lower lateral extension onto basal radular membrane. Inner marginal tooth long, hooklike and tapering to pointed tip, serrated on both sides with 3–5 tiny denticles. Outer marginal tooth same, only smooth on outer surface. Basal half of each marginal tooth becomes wider and flatter where it is inserted onto the basal radular membrane.

*Animal*: Head-foot of preserved animals large and with deep groove emerging from exhalant siphon and extending down right side of foot. Snout long, bilobed at tip. Eyes very large in relation to animal. Mantle edge with short, thick pallial tentacles. Organs of mantle cavity and internal anatomy unknown. Eggs and larvae unknown.

*Etymology*.—From the Latin, *pauxillus*, “little,” “small.”

### Discussion

*Synonymy*.—This species was first described by A. Adams (1854) as a *Cerithidea* species, family Potamididae H. and A. Adams, 1854, but was considered a *Cerithium* species by Sowerby (1855; 1865), Tryon (1887) and Kobelt (1898). Shell sculpture, radular and opercular characters substantiate its proper assignment to the Cerithiidae. Adams' (1854) original diagnosis was without a figure but described a “yellowish-brown shining species with deeply channeled sutures, and with the whorls ornamented with 3 series of rather acute tubercles.” His description also noted the unusually shaped aperture with sinuous lip and the posterior siphonal canal. Examination of the holotype shows it to be conspecific with recent material and the other synonyms given above.

The nominal species, *pauxilla*, has been overlooked because of the poor, tiny figures in Sowerby (1855; 1865) and the other classical iconographies which do not clearly illustrate the sculpture or distinctive features of the aperture. As a result, a number of names have been proposed, as can be seen in the above synonymy. The homonym, *Cerithium pauxillum* Pease, 1860, is a different species.

The earliest synonym is *Cerithium bicanaliferum* Brazier, 1877. This name appropriately describes the unique siphonal canals. The names *bicanaliferum* and *pauxillum* were missed by Melvill (1910), who named the species, *trigonostomum*, “triangular mouth.” The type-material of *C. trigonostomum* comprises 4 specimens, 2 of which were purchased by Sowerby and Fulton and have the registry number 1912.8.16.97-8. The other 2, lacking registry numbers, are from the F. W. Townsend collection. I select the best preserved specimen from the Townsend collection as the lectotype of *C. trigonostomum* because Melvill's (1910) paper was written about the mollusks collected by Townsend.

Gründel (1976) proposed the genus *Varicopeza* to accomodate what he thought was a new species and was apparently unaware of the other available specific names.

Examination of the holotype of *Argyropeza involuta* Thiele, 1918, has convinced me that it is conspecific with *Varicopeza pauxilla*. Thiele's specimens are both immature individuals lacking outer lips and were erroneously assigned by him to the genus *Argyropeza* Melvill and Standen, 1901. Although related to the genera *Bittium* and *Varicopeza*, *Argyropeza* species differ in having a distinctive protoconch sculpture of 2 spiral cords, a spiral row of beads adjacent to the suture, and a sinusigera notch.

*Remarks.*—*Varicopeza pauxilla* is a common species, widely distributed throughout the continental shelf and slope regions of the Indo-West Pacific biogeographic province.

The color of this species is variable. Dead collected specimens tend to be chalky white while freshly collected material is white or light tan and of porcellaneous texture. Some shells are flesh colored or dark tan: a series of specimens from Palau (ANSP 203855;203483) ranged in color from white to brown, many being striped with a dark tan band on the lower half of each whorl. A summary of the shell dimensions and characters is presented in Table 1, below:

Table 1.—Statistical summary of shell measurements (mm) of *Varicopeza pauxilla*.

Character	Number	Range	Mean	S.D.
Length	64	3.5–9.6	6.89	1.3
Width	64	1.4–2.8	2.15	0.35
Aperture length	64	0.5–2.0	1.21	0.35
No. whorls	64	8–14	11.3	1.29

Adults, with fully formed body whorl, varix, outer lip, and two siphonal canals are so distinctive that they are unlikely to be confused with any other small, deep-sea cerithid (Fig. 1a–e). Immature individuals or shells without the outer lip may be difficult to identify without close examination of the distinctive sculptural pattern. *Varicopeza pauxilla* may be confused with young individuals of *Rhinoclavis (Proclava) sordidula* (Gould, 1849) which have similar sculpture. The latter species differs by being much larger and in having a median columellar plait in the aperture and a sutural ramp only on the bottom portion of each whorl.

*Cerithium elegantissimum* Hedley, 1899 resembles *Varicopeza pauxilla* in that the outer lip flares slightly, forming a weak exhalant posterior siphonal canal, but the shell is less slender and has different sculpture. The former is clearly more like *Bittium* and forms a morphological link between that genus and *Varicopeza*.

*Cerithium scabriusculum* Issel, 1869, may be a synonym of *Varicopeza*

*pauxilla*. I have not examined the type-material, but Issel's (1869:pl. 3, fig. 11) illustration looks somewhat close to *Varicopeza pauxilla*.

*Varicopeza pauxilla* may also be mistaken for a turrid species because of the similarity of the exhalant posterior siphonal canal to the "turrid notch." Turrids however, normally have narrower apertures and slightly longer anterior siphonal canals.

*Ecology*.—The ecological information available suggests that this deep-sea species is a microphagous detritivore and perhaps a filter feeder, as well. It lives in great numbers on soft or fine sandy-muddy bottoms and has a radula that is morphologically and functionally similar to those of *Bittium* species. The numerous rod-shaped, ovoid fecal pellets of fine detrital particles are relatively large in comparison to the size of the animal, indicating a continuous feeding habit. The deep groove leading from the exhalant siphon down the right side of the foot probably conveys mucous, fecal pellets and other debris away from the animal. It is more pronounced than in other cerithid species. The functional significance of the wide, exhalant, posterior siphonal canal may be explained in terms of filter feeding on a soft substratum. The inhalant and exhalant siphonal canals allow the animal to lie with its aperture tangential to the surface of the substratum and may expedite the flow of water and detrital particles through the mantle cavity. Normal grazing activity can also take place. It does not appear that the animals are partly buried in the sediment because none of the specimens examined were eroded or worn on the dorsal or ventral surfaces of their shells. I thus suggest that this small cerithid snail grazes and filter feeds at the water-substratum interface.

Many specimens examined from the Philippines, Palau, and the Andaman Sea were drilled, indicating heavy predation by naticid snails. Many empty shells from Palau contained sipunculids.

Although the protoconch is large, consisting of 3.5 whorls, the smooth sculpture and spout-like notch (Fig. 1g) in the upper edge of the outer protoconch lip and the absence of a sinusigera notch point to a direct or demersal developmental mode rather than to an indirect, pelagic one.

*Geographic distribution* (Fig. 3).—The bathymetric range of this species is summarized in Table 2. The geographic range is confined to the Indo-West Pacific province. The one record from Bikini Atoll, Marshall Islands, indicates that this species may yet be found in other areas of Micronesia and possibly in Polynesia.

#### Specimens Examined

GULF OF AQABA: off Elat, 167 m; Elat, 121 m; Elat, 40–49 m; off Mersat Abu Samra, 52 m; off Wadi Murach, 80–82 m; off Gesirat Fara'un, 64–73 m; Elat, from beach; off Nuweiba el Tarabin, 143–146 m; off Nuweiba



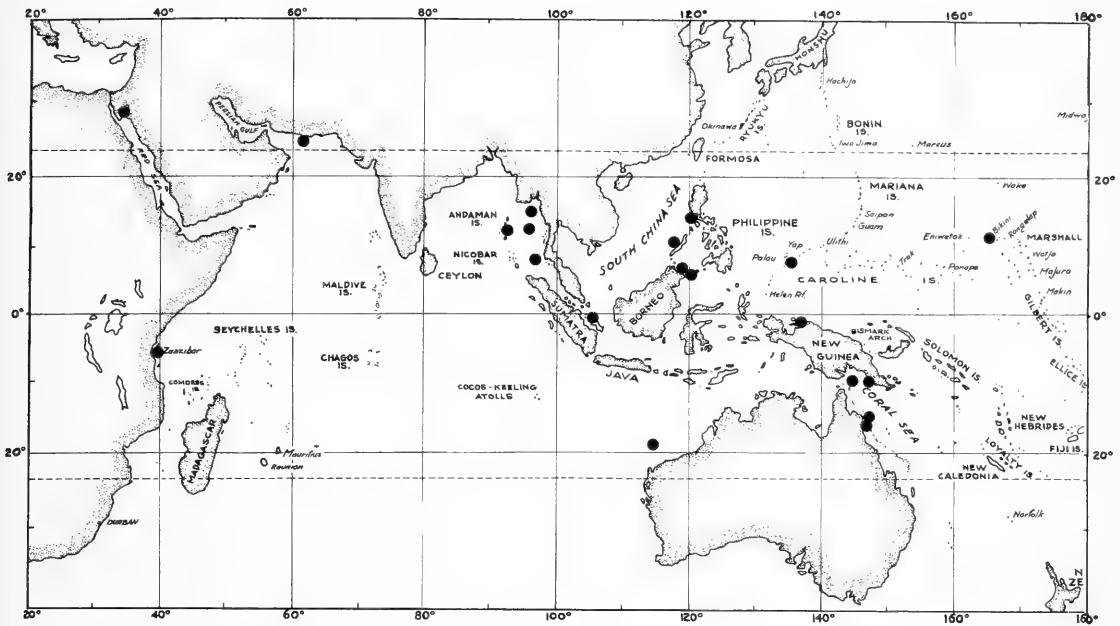


Fig. 3. Geographic distribution of *Varicopeza pauxilla* (A. Adams).

el Museina, 329–402 m (all USNM 783672–783678). ZANZIBAR: 5°27.9'N, 39°18.8'E, 463 m, near Zanzibar (BM); 2 mi. W of Nyange Id., 20 m (ANSP 251215). INDIA: 10 mi. SE of Vizagapatnam, 58 m, Bay of Bengal (ANSP 294094). BURMA: 15°08'N, 99°04'E, 50 mi. SW of Irrawaddy River, Pre-paris N. Channel, 53 m (ANSP 293491). ANDAMAN SEA: 13°N, 97°4'E, 35 mi. W of Tavoy Id., Andaman Sea, 68 m (ANSP 292782); 08°29'N, 97°59'E, 25 mi. NNW of Phuket Id., W. Thailand, 42 m (ANSP 291467; 291826); 12°01'N, 92°55'E, 14 mi. NNW of Port Blair, off S. Andaman Ids., 49 m (ANSP 292348). WESTERN AUSTRALIA: Approximately 170 mi. W of Port Hedland, W.A., 19°29'S, 116°01'E, 137 m (AMS). QUEENSLAND, AUSTRALIA: off Endeavour Reef, N of Cooktown, 37 m (AMS); Dornley Id., Torres Straits, 55 m (AMS A-72); Palm Id., N of Townsville, 27 m (AMS C10188); Low Isles, near Port Douglas (AMS); Palm Id., (NMV). NEW GUINEA: 1–2 mi. off Kaipouri Village, Koeroedoe Id., Geelvink Bay, 15 m (ANSP 277870); 1 mi. S by E. Cape Dgaroewawoffi, Japen Id., Geelvink Bay 12–29 m (ANSP 277723); W end Manubada (Local) Id. off Port Moresby, Papua, 18–22 m (AMS). PALAU: 1–1.5 mi. off

Table 2.—Bathymetric range of *Varicopeza pauxilla*.

No. of stations	Depth range (meters)	Mean depth	S.D.
48	11–686	90.92	122.36

Garakasan Point, E side of Babelthaup (ANSP 203855); off Malakal Harbor, 46–55 m (ANSP 236589; 203483). MARSHALL ISLANDS: 3 mi. SW of Bikini Id., Bikini Atoll, 46 m (USNM 586688). PHILIPPINES: off SE Tawi-tawi, 33 m (USNM 283634); Palawan Pass, off Cauayan Id., 95 m (USNM 258481); Linapacan Str., off Observatory Id., Palawan, 84 m (USNM 282437); SE off Bantayan Id., 59 m (USNM 281081); S off Corregidor Lt., 55 m (USNM 263530); off Toccanhi Pt., Tawi-tawi, 90 m (USNM 274414); off Nagubat Id., E. Mindanao, 80 m (USNM 276898); off Mantaquin Id., E. Palawan, 49 m (USNM 288300); off Tacbuc Pt., E. Leyte, 88 m (USNM 282853); off Tacbuc Pt., E. Leyte, 104 m (USNM 283184); Linapacan Str., off Observatory Id., 84 m (USNM 282792); off Tinakta Id., Tawi-tawi Is., 29 m (USNM 257689); Linapacan Str., off Observatory Id., Palawan, 84 m (USNM 291621); off S. W. Tawi tawi, 33 m (USNM 312733); off Malavatuan Id., W. Luzon, 33 m (USNM 278223); off Observatory Id., Palawan Pass, 79 m (USNM 282334); off Observatory Id., Palawan Pass, 79 m (USNM 282023); off Tinakta Id., Tawi tawi, 29 m (USNM 257690); Palawan Pass, off Pt. Tabonan, 686 m (USNM 285856); off Sueste Pt., W. Luzon, 46 m (USNM 262609); off S.W. Tawi tawi, 33 m (USNM 312727); Malampaya Sound, Palawan, 11 m (USNM 286138); S.E. off Bantayan Id., 59 m (USNM 281061). BORNEO: off Sandakn Lt., 71 m (USNM 285765).

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*PSEUDOCHIRELLA SQUALIDA* GRICE &  
HULSEMANN, 1967, FROM  
CONTINENTAL SLOPE WATERS  
OFF DELAWARE (COPEPODA: CALANOIDA)

Frank D. Ferrari

*Abstract.*—The original description of copepodid stage VI female *Pseudochirella squalida* is augmented. Initial descriptions of stage VI male, stage V female, and stage V male are presented. Sexually dimorphic characters in both stages are present in a variety of body segments, appendages, and their armature. Some of their presumed functions are discussed. Bilateral asymmetry is exhibited only in stage VI and is manifested in primary or secondary sexual characters.

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Introduction

The establishment of *Pseudochirella squalida* by Grice & Hulsemann (1967) was based on a single copepodid stage VI female specimen collected in the Indian Ocean on 28 June 1964 at ANTON BRUUN station 351B (29°45'S, 64°58'E) between 350 and 1,710 m. Deevey & Brooks (1977) reported 2 females in the Sargasso Sea collected at Station "S" (32°10'N, 64°30'W) on July 1969 and February 1970 between 500 and 1,000 m. To date examination of calanoid copepods from midwater trawl samples of 2 cruises (July 1975, ALBATROSS IV, and February 1976, OREGON II) in the area of Deepwater Dumpsite 106 in continental slope waters off Delaware has shown *P. squalida* to be the most abundant species of the genus. In this paper I augment the description of the external morphology of copepodid stage VI female (hereafter VI ♀), describe copepodid stage VI male (VI ♂), copepodid stage V female (V ♀), and copepodid stage V male (V ♂) and discuss sexual dimorphism and bilateral asymmetry among the various stages.

Materials and Methods

Specimens were examined from midwater trawl samples collected during cruises to Deepwater Dumpsite 106, an area encompassed by 70°31'–75°00'W and 36°00'–39°10'N. A more complete description of the gear and station positions is given by Krueger *et al.* (1977). Table 1 gives collection data for the samples containing *P. squalida*.

All specimens of *P. squalida* were removed from every sample and

measured. They were prepared for examination by clearing in lactic acid and staining with chlorazol black E. In the following presentation VI ♀ is described and illustrated completely. VI ♂, V ♀, and V ♂ are compared to this description and only those structures differing significantly from VI ♀ are illustrated. For clarity, illustrations of spines, setae and their ornamentation are not complete. Generally for similar articles or elements in a series only one is illustrated completely. In a few cases individual variation occurs in the number of setae comprising large clusters, e.g. RiA2, RiMd or RiMx1. These instances are not reported as it is impossible to determine whether the setae were lost during preparation, not observed due to imperfect staining, or actually represent individual variation. Illustrations were made with the aid of camera lucida or drawing tube. Anatomical terminology and abbreviations follow Ferrari and Bowman (in press) except for the mouthparts where terminology and abbreviations of Giesbrecht (1892) are used.

## Results

### *Pseudochirella squalida* Grice & Hulsemann 1967

*Pseudochirella squalida* Grice & Hulsemann 1967:24, figs. 65–70.

**Material.**—71 VI ♀, 10 VI ♂, 18 V ♀, 61 V ♂ from 27 midwater trawl samples listed in Table 1.

**Description.**—VI ♀: Length range 5.5–6.8 mm. Cph/Pg1 articulation (Fig. 1e) free laterally, fused dorsally. Pg4/Pg5 fused. Ur1 (genital segment) (Figs. 1a, b; 4d, e) with row of hairs across dorsal surface. Left side of Ur1 produced midlaterally into slight bulge, accentuated by peripheral integumental ridges; posterolaterally a small bump; series of integumental ridges across ventrolateral face; small patch of anterolateral hairs. Right side 2 large posterolateral bumps with long hairs; integumental ridges across ventrolateral face; scattered hairs dorsally. Ventral surface slightly produced into genital prominence with accentuating integumental ridges; large transverse ridge posteriorly, with associated hairs. Ur2&3 (Fig. 1a) with thin hairs scattered over entire segment; distinctly thicker hairs along posterodorsal margin. CR with hairs dorsally and laterally; first terminal setae reduced, originating from ventral surface; remaining terminal setae and dorsal seta long, thick and plumose; lateral seta small. A1 (Figs. 2c–e) 24 free segments, 8–9 fused. 1A1 with tiny spines; esthetes on 2,3,5,6,9,13,18,25. B1A2 (Fig. 2a) proximal comb of 6–7 setules; 1 distal seta. B2A2 2 distal setae. Re 7 segments; Re2–6 1 seta each; Re7 1 seta midlength, 3 distally. Ri1 2 distal setae; Ri2 separate group of setae on 2 distal edges, lateral edge 8 setae, medial 9. B1Md as shown (Fig. 3a); hairs of varying thickness on anterior surface. B2 3 medial setae. ReMd 5 segments; Re1–4 1 seta each Re5 with 2. Ri1Md 3 medial setae, thin hairs laterally; Ri2 10 distal setae. LeMx1 9 setae (Fig. 3c); Re 9 setae;

Ri 16 setae. B2 5 distal setae. Li3 4 setae; Le2 5 setae. Li1 10 anterior spines with long spinules; 4 posterior spines with short, thick spinules; hairs on anterior surface. B1Mx2 (Fig. 3e, f) with lateral spinules. L1–5Mx2 with small spines on posterior surface; each lobe 3 long spines with spinules or plumes. Ri 5 segments; Ri1–4 with large medial spine and reduced posterolateral spine; Ri5 3 well-developed spines. B1&2Mxp with rows of spinules as illustrated (Fig. 4b). B1 3 groups of 3 spines. B2 2 medial spines with spinules and 3 plumose setae. Ri 5 segments; with 0,0,0,1,1 lateral setae and 3,4,3,3,3 medial spines with spinules. B1P1 (Fig. 5a) row of medial hairs; B2 row of medial hairs and strong curved distal spine extending over tubercle of Ri. Re 3 segments; articulation between Re1&2 incomplete. Re1 with medial hairs and 1 Se with spinules. Re2 medial hairs, tiny spines on anterodistal edge, 1 Se with spinules and 1 Si. Re3 hairs on anterior surface and along lateral edge, Se with spinules, 1 St plumose medially, spinules proximolaterally, serrate flange distolaterally, and 3 Si. RiP1 1 segment, forming medial tubercle on anterior face, with tiny spines (see Vaupel-Kline, 1972, for a more complete discussion of this structure in *Euchirella*), anterodistal hairs, 5 Si. B1P2 (Fig. 3h) medial hairs and 1 Si. B2 naked. ReP2 3 segments. Re1 medial hairs, 1 Se with serrate flange on both edges, 1 Si. Re2 similar to Re1 but with row of tiny anterodistal spines, lateral hairs, and lacking medial hairs. Re3 3 biflanged Se; St plumose medially, serrate flange laterally, and 4 Si. P3 (Fig. 3i) similar to P2 except Ri 3 segments. Ri1 1 Si. Ri2 lateral hairs and 1 Si. Ri3 posterior and lateral hairs, 1 Se, and 4 Si. P4 (Fig. 4a) similar to P3 except B1 medially formed lobe with comb of strong spines, 6–7 on left B1; 8–10 on right. B2 with posterior hairs. Ri2 with posterior hairs. P5 absent.

VI ♂: Length range 5.1–5.8 mm. Cph/Pg1 fused (Fig. 1d). Pg4/Pg5 fused; small unarticulated, slightly curved, posterodistal spine on each side. Ur1 (Fig. 1c) genital opening on left side. Ur2–5 posterodistal serrate fringe; without hairs on surface of segments. CR smaller than VI ♀ with fewer dorsal hairs; medial 2 setae longer than VI ♀. A1 (Figs. 2f–h) 24 free segments; 8&9 fused; articulation between 9&10 and 12&13 fused posteriorly; many more esthetes especially on proximal segments. B1A2 (Fig. 2b) distal seta reduced. B2 2 distal setae reduced. Re similar to VI ♀ but seta on Re2 and 1 on Re7 absent. Ri1 naked. Ri2 mediobasal series with 7 setae; laterodistal with 6. B1Md (Fig. 3b) gnathobase reduced to knob. B2 1 medial seta. Re all segments fused, with 6 setae. Ri1 lateral hairs and 2 medial setae. Ri2 9 distal setae. Mx1 (Fig. 3d) greatly reduced. Le 7 setae. Re 11 setae. Ri&B2 fused. Ri 10 setae; B2 with 5. Li3 2 small setae. Li1&2 naked. Mx2 (Fig. 3g) greatly reduced, all segments fused. L1–5 small knobs with 1,2,2,2,2 setae; L5 distal seta with swollen base. Ri 5 setae. Mxp (Fig. 4c) slightly reduced. B1 1 medial and 2 distal setae; small spines absent. B2 5 medial setae; no small spines. Ri with 3,3,2,2,3 medial spines; 0,0,0,1,1 lateral setae. P1 (Fig. 5f) slightly reduced, similar to VI ♀ but Re1&2 artic-



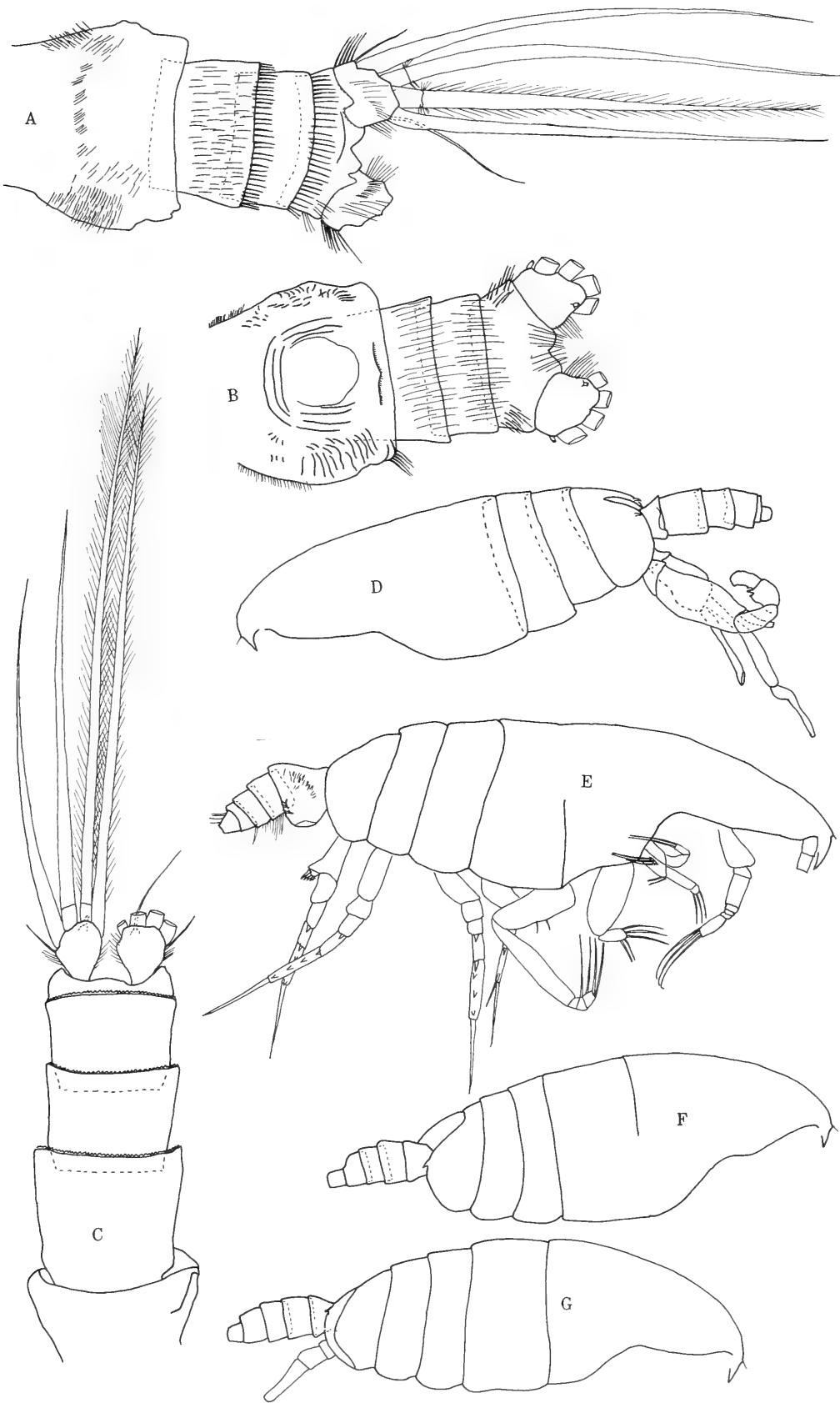


Fig. 1. *Pseudochirella squalida*: a, VI ♀ Ur, dorsal; b, VI ♀ Ur, ventral; c, VI ♂ Ur, dorsal; d, VI ♂ habitus, left lateral; e, VI ♀ habitus, right, lateral; f, V ♀ habitus, right lateral; g, V ♂ habitus, right lateral.

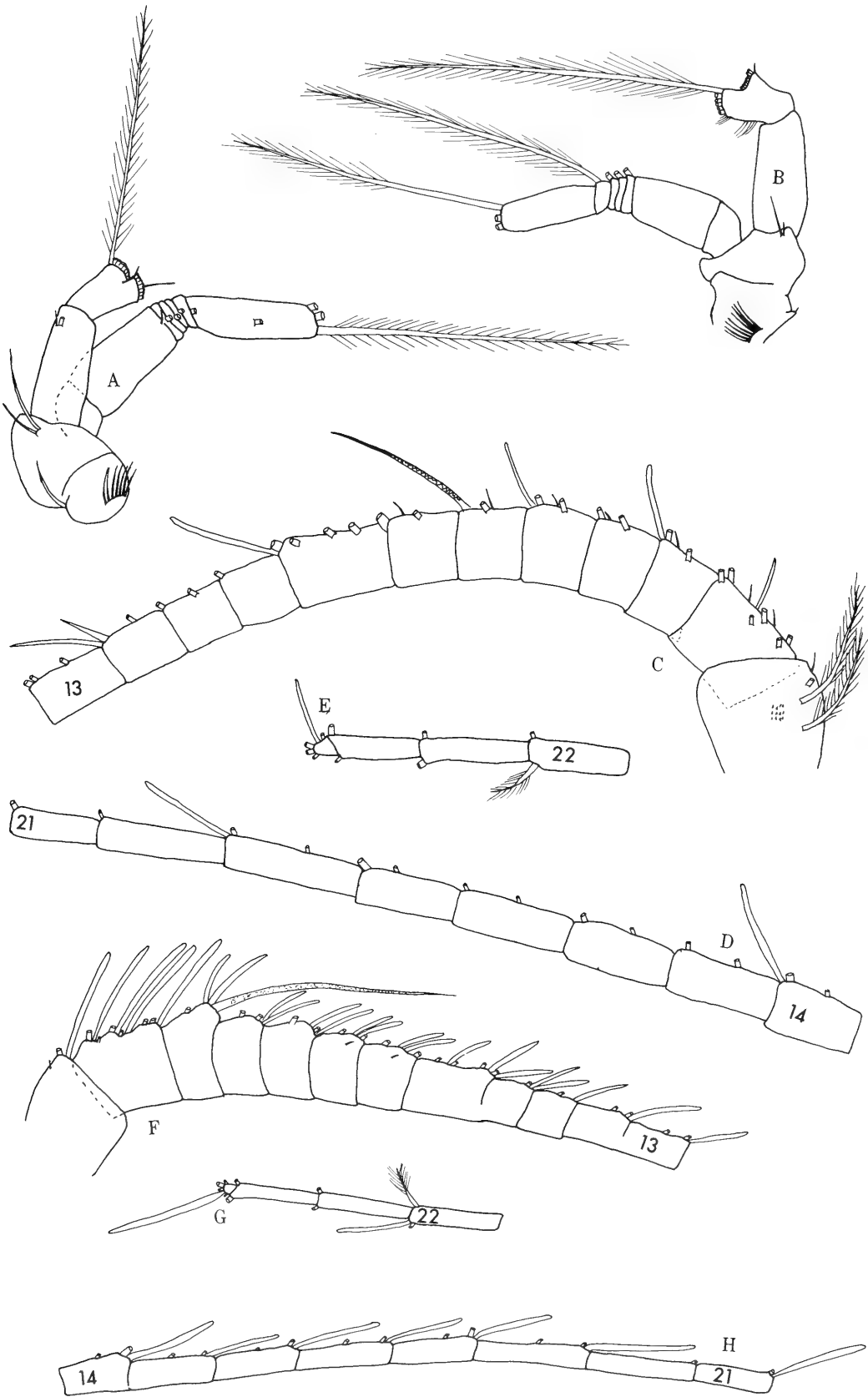


Fig. 2. *Pseudochirella squalida*: a, VI ♀ A2; b, VI ♂ A2; c, VI ♀ A1, 1-13; d, VI ♀ A1, 14-21; e, VI ♀ A1, 22-25; f, VI ♂ A1, 1-13; g, VI ♂ A1, 14-21; h, VI ♂ A1, 22-25.

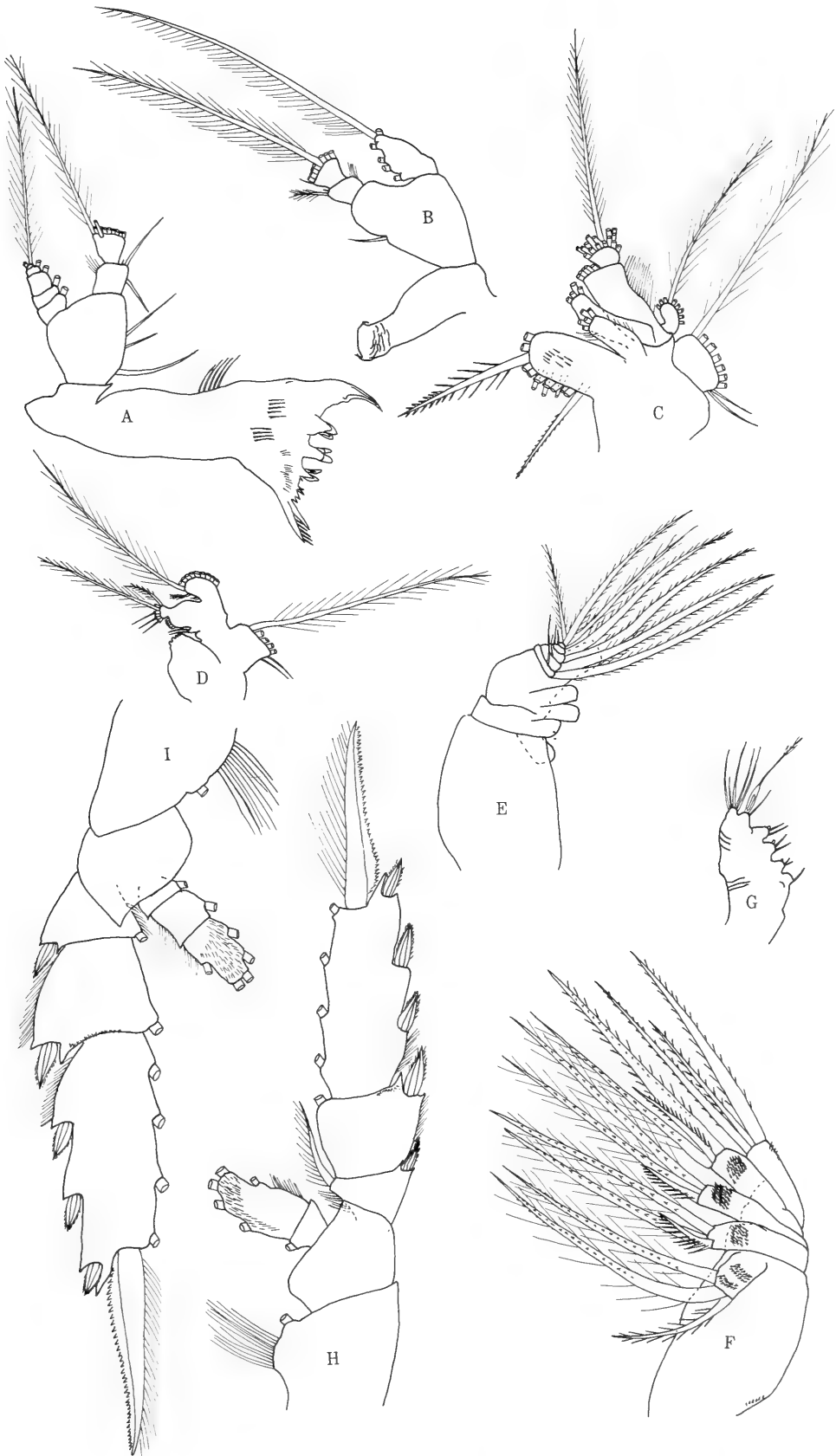


Fig. 3. *Pseudochirella squalida*: a, VI ♀ Md, posterior; b, VI ♂ Md, posterior; c, VI ♀ Mx1, posterior; d, VI ♂ Mx1, posterior; e, VI ♀ Mx2, posterior; f, VI ♀ Mx2, anterior; g, VI ♂ Mx2, posterior; h, VI ♀ P2, posterior; i, VI ♀ P3, posterior.



Fig. 4. *Pseudochirella squalida*: a, VI ♀ P4, posterior; b, VI ♀ Mxp, posterior; c, VI ♂ Mxp, posterior; d, VI ♀ genital segment, right lateral; e, VI ♀ genital segment, left lateral; f, VI ♀ genital segment with spermatophore, left lateral; g, VI ♀ genital segment with spermatophore, right lateral.

ulation complete; SeRe1 reduced and naked; SeRe2 thick and naked; SeRe3 naked. P2&3 similar to VI ♀. P4 (Fig. 5c) also similar except B2 comb of spines absent and posterior hairs on B2&Re2 absent. P5 (Figs. 5d&e) well-developed, complicated and asymmetrical. Left and right B1 fused to coupler. Left B2 larger than right. Left Re 3 segments. Re2 with medial blade and 2 mediobasal tooth-like projections. Re3 with medial tooth-like projection and mediobasal patch of hairs. Left Ri 1 segment extending slightly beyond Re1. Right Re 2 segments. Re1 bent laterally, extending to middle of left Re2. Right Re2 with proximomedial ridge and several ridges distolaterally. Right Ri 1 segment extending to end of left Ri; tip ovate; ridge on anterior side.

V ♀: Length range 4.3–4.7 mm. Cph/Pg1 (Fig. 1f) fused laterally. Pg4/5 fused. Pg5 with points similar to VI ♂. Ur 4 segments. Ur3&4 with dorsal and ventral hairs and posteroventral serrate marginal fringe. CR similar to VI ♀. Appendages also similar except as noted. Ri2A2 1 seta. Ri3 8 medial and 6 lateral setae. Ri2Md with 9 distal setae. ReMx1 10 setae; Ri 15 setae. RiMx2 incompletely fused at base. Ri2Mxp 3 spines; Ri3&4 with 2 each. Ri1&2P2 articulation partially fused. Ri1&2P3 articulation partially fused. B1P4 comb of spines absent. P5 absent.

V ♂: Length range 4.6–5.0 mm. Cph/Pg1 separate (Fig. 1g). Pg4/5 separate. Pg5 points similar to VI ♂. Ur 4 segments. Ur2&3 with posteroventral serrate marginal fringe. Appendages similar to VI ♀ except as noted. Ri2A2 1 seta. Ri3 8 medial and 7 lateral distal setae. Re2&3Md fused. ReMx1 9 setae. RiMx2 fused to B2. Re2&3P1 without anterior hairs. Ri1&2P2 partially fused. Ri1&2P3 partially fused. B1P4 without comb of spines. P5 (Fig. 5b) symmetrical. Left and right B1 fused. Re and Ri each as simple, undifferentiated segment.

### Discussion

As shown in Table 1, 3 other species of the genus have been collected with *Pseudochirella squalida*: *P. obtusa* VI ♀ (1 specimen); *P. pustulifera* VI ♀ (6), VI ♂ (1), V ♂ (2); *P. scopularis* VI ♀ (1). Most mature and juvenile specimens of the 4 species were captured between 400 and 1,825 m, the depths to which most tows were confined. Capture data did not indicate evidence of particular sex or stage occupying well-defined or exclusive depth zones.

Twenty VI ♀♀ of *P. squalida* were found with spermatophores attached ventrally on the genital segment (16 with 1 spermatophore, 3 with 2, and 1 with 3). Unlike some species of *Pseudochirella* and species of the related genus *Echirella*, *P. squalida* does not have a distinctly well-sculptured area on the genital segment (see descriptions and illustrations in Vervoort, 1949; Park 1975, 1976a, 1976b, 1977). Areas such as the large dorsal lobe on *Euchirella messinensis* and the large protrusion on *E. truncata* serve as spermatophore attachment points away from the genital field. Fertilization

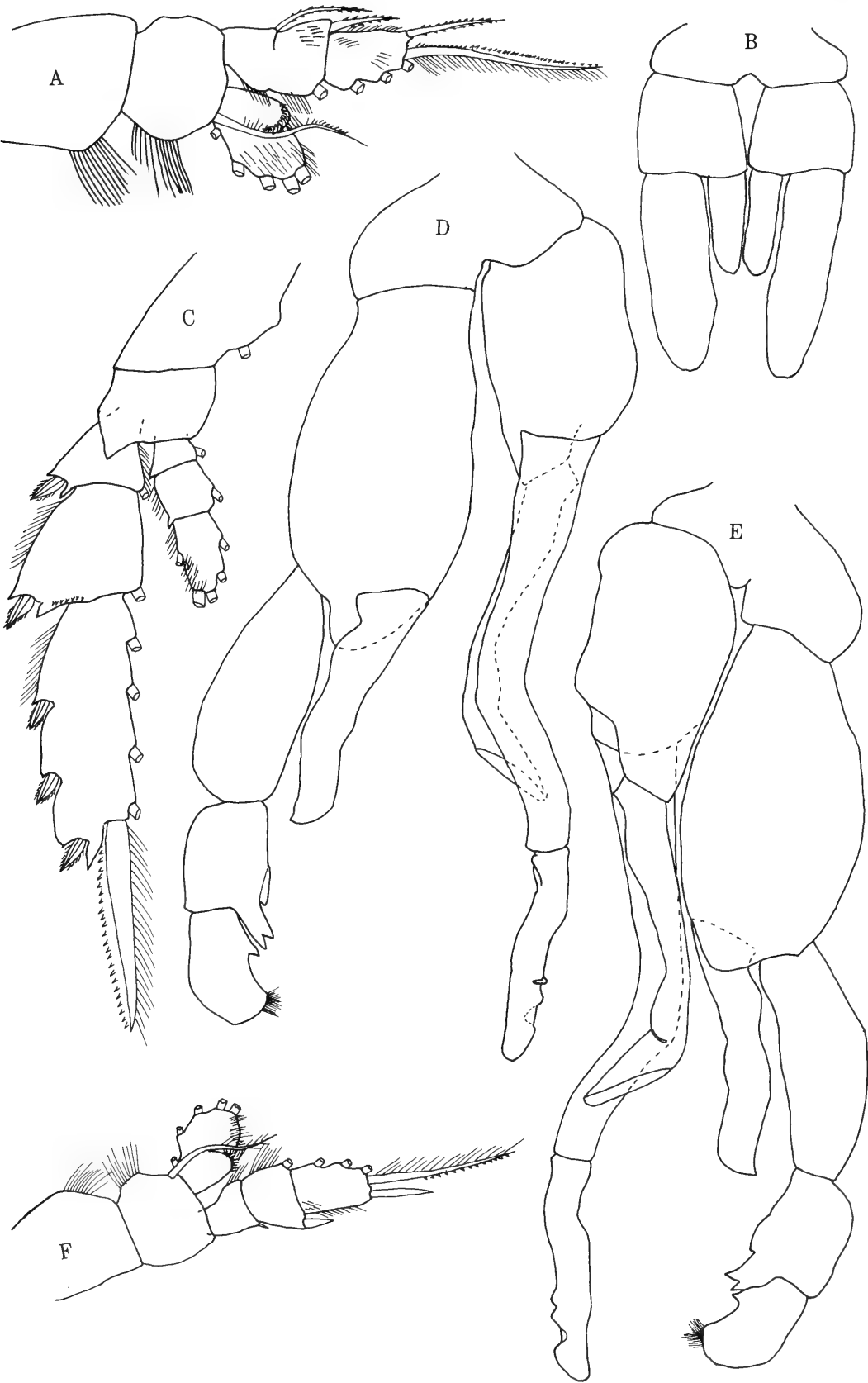


Fig. 5. *Pseudochirella squalida*: a, VI ♀ P1, anterior; b, V ♂ P5, posterior; c, VI ♂ P4, posterior; d, VI ♂ P5, posterior; e, VI ♂ P5, anterior; f, VI ♂ P1, anterior.



Table 1.—Samples from which *Pseudochirella squalida* were taken.

Cruise	Station	Date	Latitude (N)	Longitude (W)	Tow depth (m)	VI ♀	VI ♂	V ♀	V ♂	other <i>Pseudochirella</i>
2	7C	23 July 75	38°52'	072°04'	400–600				1	
2	14A	24 July 75	38°38'	072°03'	800–1,000	1				
2	17B	24 July 75	38°33'	072°10'	600–800				1	
2	23A	25 July 75	38°35'	072°08'	1,425–1,839					<i>pustulifera</i> 3 VI ♀, 2 V ♂ <i>obtusa</i> 1 VI ♀
2	24B	25 July 75	39°03'	072°04'	600–800	3	1	1	4	
2	24C	25 July 75	39°03'	072°04'	500–600	1		2	3	
2	25C	26 July 75	38°41'	072°02'	400–500	1		1		
2	45B	28 July 75	38°44'	072°02'	800–947					<i>pustulifera</i> 1 VI ♀
2	47B	28 July 75	38°56'	072°20'	600–700	2				
2	51B	29 July 75	38°51'	072°28'	700–800	1				
2	61A	30 July 75	38°52'	072°24'	900–1,085	1				
2	65B	31 July 75	38°46'	072°20'	600–700		1			
2	65C	31 July 75	38°46'	072°20'	500–600	1				
2	75A	1 August 75	38°38'	072°43'	700–800	2			1	
2	75C	1 August 75	38°38'	072°43'	500–600					<i>scopularis</i> 1 VI ♀
2	78A	1 August 75	38°43'	072°45'	700–800				1	
2	78C	1 August 75	38°43'	072°45'	500–600	2		2	6	
2	82A	2 August 75	38°48'	072°40'	700–800	2				
2	82B	2 August 75	38°48'	072°40'	600–700				4	
2	82C	2 August 75	38°48'	072°40'	500–600				1	
2	85C	2 August 75	38°57'	072°25'	800–1,000	1	1			
3	2A	20 February 76	37°01'	074°08'	400–500	28	6	15	30	
3	2B	20 February 76	37°01'	074°08'	300–400	8		3	5	
3	2C	20 February 76	37°01'	074°08'	200–300				1	
3	2M	20 February 76	37°01'	074°08'	0–200	1		1		
3	3A	21 February 76	37°09'	074°06'	700–800	1				<i>pustulifera</i> 3 VI ♀
3	3B	21 February 76	37°09'	074°06'	600–700	15	1	3	2	<i>pustulifera</i> 1 VI ♂

Table 2.—Characters which exhibit sexual dimorphism in stage V or stage VI and their state in the remaining stage.

Character	VI ♀	VI ♂	V ♀	V ♂
Cph/Pgl	fused dorsally	fused entirely	fused laterally	free
Pg4/Pg5	fused entirely	fused entirely	fused entirely	free
Pg5 points	absent	present	present	present
Ur	4 segments	5 segments	4 segments	4 segments
position, genital opening	ventral	lateral (left)	absent	absent
Ur marginal hairs	Ur 2&3	none	none	none
Ur marginal fringe	none	Ur 2-4	Ur 2&3	Ur 2&3
CR setae		longer than VI ♀	similar to VI ♀	similar to VI ♀
Al	8&9 fused 9&10 free 12&13 free	8&9 fused 9&10 part free 12&13 part free	similar to VI ♀	similar to VI ♀
A2 setae Re	9	7	9	9
Ri	19	15	15	16
Md gnathobase	well developed	reduced teeth absent	well developed	well developed
setae B2	3	1	3	3
segments Re	all free	all fused	all free	2&3 fused
setae Ri	13	11	12	12
Mx1 size		greatly reduced	similar to VI ♀	similar to VI ♀
spines Li1	14	0	14	14
setae Li2	5	0	5	5
setae Li3	4	2	4	4
setae Ri	16	10	15	15
setae Re	9	11	10	9
setae Le	9	7	9	9
Mx2 size		greatly reduced	similar to VI ♀	similar to VI ♀
spines L1	3	1	3	3
spines L2	3	2	3	3
spines L3	3	2	3	3
spines L4	3	2	3	3
spines L5	3	2	3	3
spines Ri	11	5	11	11
segments Ri	all free	all free	Ri1/B2 fused	all free
Mxp size		reduced slightly	similar to VI ♀	similar to VI ♀

Table 2.—Continued.

Character	VI ♀	VI ♂	V ♀	V ♂
spines B1	9	3	9	9
spines Ri	18	15	15	15
P1 size		reduced slightly	similar to VI ♀	similar to VI ♀
Ri1 & 2 margin Se	partly fused spinules	free smooth	partly fused spinules	partly fused spinules
P4 B1	spine comb	absent	absent	absent
P5	absent	large complex	absent	small simple

tubes serve to connect the sperm sac to the genital opening (unpublished observations).

Spermatophores of *P. squalida* were attached on the sternum to the left or right of the genital plate. Multiple spermatophores were also attached in this area. Figs. 4f, g show left and right lateral views of VI ♀ genital segment with the sperm sac narrowing to a short neck and attached to the left sternum by a simple plate. Several spermatophores including the one illustrated were partly empty, the distolateral areas absent. A similar situation was reported for *Euchaeta norvegica* and the implications discussed by Ferrari (1977). In the illustrated example the genital plate appears flexed up into the genital segment and a large mass of material seems to fill the vacated space below it. This mass was not detected on specimens with full spermatophores. Due to the thick cuticle and opaque structures associated with the spermatophore it was impossible to determine anything more of the relations of the mass, genital plate and pore, and seminal receptacle.

Characters which exhibit sexual dimorphism in either stages V or VI and their development in the remaining stage are described in Table 2. Very little is known of calanoid behavior in general or even of the function of various appendages, segments, or their armament. Nothing is known of the behavior of *P. squalida*. However some suggestions about the function of these sexually dirmorphic characters can be made based on studies of other calanoids. The characters can be artificially grouped into: those for which some information is available through behavioral observations of homologous morphological characters in other calanoids; those for which there is no homologous behavioral information but information about comparative morphology may permit some conjecture; those for which no statements can be made.

In the first group the reduction in size and/or ornamentation or A2, Md, Mx1, Mx2, and Mxp in VI ♂ indicates an inability of these animals to feed. This is further substantiated by the degenerate condition of the gut (unpub-

Table 3.—Comparison of sexual dimorphism (sd) and bilateral asymmetry (ba) for both sexes of stage V and stage VI.

	ba	sd
V	♀ None	Cph/Pg1 articulation
		Pg4/Pg4 articulation
		A2
	♂ None	Md
		Mx1
		Mx2
VI	♀ Genital segment	P5
		Cph/Pg1 articulation
		Pg4 points
		Ur-shape and number of segments
		Ur-margin of segments
		CR-length of setae
	P4 comb of spines	A1
		A2
		Md
		Mx1
		Mx2
		Mxp
	♂ Genital segment	P1
		P4
		P5
	P5	

lished observations). Significant reductions occur in teeth of B1Md gnathobase and strong spines of LiMx1 and L1–5Mx2 which probably hold, tear, and crush the food prior to ingestion.

Concerning the VI ♂ P5 and VI ♀ Ur1 (genital segment) much has been written about the Centropagidae (Lee, 1972, and Blades, 1977), *Labidocera* (Fleminger, 1975 and Blades & Youngbluth, 1979) and *Euchaeta norvegica* (Hopkins *et al.*, 1978). The VI ♂ uses his P5 to clasp the ♀ and position himself immediately prior to spermatophore transfer which is accomplished by his left ReP5. The shape of the VI ♀ genital segment may mirror the clasp of her mate as well as the position of the spermatophore.

Regarding the second group of characters, sexual dimorphism in A1 of VI ♀ and ♂ is manifested in greater number of esthetes of the ♂. Griffiths & Frost (1976) state that VI ♂ esthetes on *Calanus pacificus* and *Pseudocalanus* sp. may be chemoreceptors upon which dissolved organic matter produced by VI ♀ accumulates. They suggest this organic matter is a pheromone.

CR setae of VI ♀ are the initial contact point of VI ♂ during mating of the heterarthrandrid copepods *Centropages typicus* and *Labidocera aestiva* (Blades, 1977, and Blades & Youngbluth, 1979). The VI ♂ grasps the VI

♀ CR setae with his geniculate right A1. Obviously this behavior does not occur during mating of *P. squalida* as VI ♂ lacks the geniculation. However such as function for the CR setae should not be precluded since another appendage could be used by the VI ♂ in the initial contact.

No direct information is available about the function of the comb of spines on B1P4 VI ♀. Considering the absence of P5 in VI ♀ and the position of the spines, it is possible that they function in an analogous manner to the reduced P5 in VI ♀ of other calanoid females. Lawson (1977) describes VI ♀ P5 of the Candaciidae as a "secondary sexual structure." Fleminger (1975) calls it a "sexually modified character" of *Labidocera*. Blades & Youngbluth (1979) have recently reported that *Labidocera aestiva* VI ♀ uses P5 to remove the spermatophore after sperm discharge.

P1 is morphologically similar to P2–4 but differs not only by the presence of the modified Ri and B2 setae but also in the ornamentation of SE Re1–3. The further sexual dimorphism in Se Re1–3 VI ♂, reduction in size and ornamentation (VI ♀ morphology is virtually identical to V ♀ and V ♂), would appear to follow the progression of such reductions in the feeding appendages anterior to it, as there are only minor morphological changes in swimming appendages posteriorly.

The functional significance of such sexually dimorphic characters as Cph/Pg1 articulation, Pg4/5 articulation, points on Pg5, number of Ur segments, position of genital opening, and posterior margins of Ur segments is not understood.

Table 3 briefly lists those external morphological characters which exhibit sexual dimorphism in either VI ♀ & ♂ or V ♀ & ♂ and compares these to characters exhibiting bilateral asymmetry. Bilateral asymmetry is apparent only in the adult, is not manifested in one sex more than the other and involves known primary or secondary sexual characters involved in reproduction.

### Acknowledgments

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LARVAL DEVELOPMENT UNDER LABORATORY  
CONDITIONS OF THE TROPICAL SPIDER  
CRAB *MITHRAX (MITHRACULUS) CORYPHE*  
(HERBST, 1801) (BRACHYURA: MAJIDAE)

Liberta E. Scotto and Robert H. Gore

*Abstract.*—The larval development of *Mithrax (Mithraculus) coryphe*, a tropical American shallow water marine spider crab is described and illustrated from stages cultured in the laboratory, and compared with larvae of *Mithrax (Mithraculus) forceps* (A. Milne Edwards, 1875). Development consists of two zoeal and a megalopal stage; a prezoal stage is hypothesized but was not observed. Temperature affects duration of development with both zoeal stages lasting 2 days each at 30°C and 3 days each at 25°C. No first crab stages were attained, but data obtained from the megalopal stages at both temperatures allowed a planktonic duration of about 10 days to be extrapolated. Larvae of *M. coryphe* are almost identical in most morphological features to those of *M. forceps*, so separation of the zoeae in the two species will be difficult; megalopal stages are more easily distinguished. Similarity in larval and postlarval stages corresponds with the general morphological similarity exhibited by adults of the two species.

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*Mithrax (Mithraculus) coryphe* is a tropical American marine spider crab distributed from the Indian River region on the central eastern Florida coast, southward throughout the eastern and southwestern Caribbean, to São Paulo, Brazil (Powers, 1977; Velez F., 1977). It is associated with rocky or coralline habitats, or seagrasses, from the intertidal zone to 55 m. The larval development of members of this genus has been little studied (see Wilson *et al.*, 1979, for summary), in spite of the easy accessibility of their habitats and the relative abundance of specimens. In a previous paper (Wilson *et al.*, *loc. cit.*) we described the complete larval development for *Mithrax (Mithraculus) forceps*, and compared morphological features in the larvae of that species to those exhibited by larvae in the subgenus *Mithrax (Mithraculus)*. In this paper we continue our investigations on this genus, by providing illustrations of the larval development of *M. coryphe*, and comparing it to larvae of *M. forceps*. This is but the third report on larvae within the genus *Mithrax*, and the second within the subgenus (*Mithraculus*).

Materials and Methods

Two ovigerous females were collected from Ninguange Lagoon, Santa Marta, Colombia, from a milleporine patch reef in 1 m of water, on 23 May



1979. The specimens were held in 8.5 cm covered glass laboratory dishes in nonflowing seawater (35‰) until hatching occurred in one female on 3 June. A total of 96 larvae, divided evenly among 4, 24-compartmented plastic trays, was cultured in controlled temperature units (CTU) at 25° and 30°C. A single tray (24 individuals) at 25°C was inadvertently starved on the day of hatching; the remaining tray at 25°C, and both trays at 30°C received *Artemia* nauplii daily; all trays received fresh seawater (35‰) daily. Light in the CTU's was on a diel cycle, 12 hours on, 12 hours off.

Illustrations and measurements of larvae were made as in the previous study (Wilson *et al.*, 1979). The descriptions and illustrations below are based on zoeae and megalopae obtained in the fed series at 25° and 30°C.

### Laboratory Culture Experiment

The larval development of *Mithrax coryphe* consists of two zoeal stages, and a megalopal stage. Whether a prezoal stage occurred is unknown; none was observed the morning of the hatch. However, other members of the genus begin their larval development with such a stage, albeit of very short duration. It is thus possible that the stage took place but was passed before the trays were examined. Duration of development in the zoeal and megalopal stage is presented in Table 1, and the percentage of larval survival is illustrated in Figure 1; both show that the duration of larval development is temperature-dependent. The minimum time spent in each zoeal stage was 2 days at 30°C and 3 days at 25°C. Regrettably, megalopal stage development was not completed at any temperature. Consequently, no firm conclusion can be made as to postlarval duration or total larval development. However, if the duration of the megalopal stage is comparable to that in *M. forceps*, then this stage probably lasts from 6–8 days. Using this value, the length of planktonic existence in *M. coryphe* at 30°C may be about 10 days, or slightly longer at 25°C. This duration is different from that observed in *M. spinosissimus* (Provenzano and Brownell, 1977), and *M. forceps* (Wilson *et al.*, 1979); the former required about 5–6 days, and the latter about 14 days, to complete planktonic development.

The larval series at 25°C which was starved for one day showed the effects of food deprivation on the early zoeal stage. The first zoeae required 5 days (as compared to 3 days in the fed series at 25°C) to complete development. Survival was poor, only 3 zoeae attaining stage II, and all dying as such. By laboratory day 4 only 12 of the original 24 zoeae starved on day 1 remained alive in stage I, whereas 19 of 20 surviving zoeae in the 25°C fed series had already molted to second stage. Three of the day-1-starved zoeae did attain stage II, but were apparently too debilitated to complete this stage; the greatest mortality in this series occurred prior to the molt to stage II. Contrarily, nearly all their counterparts in the fed series reached megal-

Table 1.—Duration of the larval stages of *Mithrax (Mithraculus) coryphe* at various temperatures.

Temperature (°C)		Duration (days)				Total number molting to next stage
		Mini- mum	Mean	Mode	Maxi- mum	
25°C (Fed)	Zoeae I	3	3	3	3	19
	II	3	3.3	3	4	7
	Megalopa	1	—	4	4	All died in stage
25°C (Starved 1 day)	Zoeae I	5	5	5	5	3
	II	1	—	—	3	All died in stage
30°C (Fed)	Zoeae I	2	2	2	3	42
	II	2	2	2	2	26
	Megalopa	1	—	3	4	All died in stage

opa, but it was throughout this stage that the greatest mortality occurred. These data, admittedly brief, suggest that the early zoeal stages of *Mithrax coryphe* probably have insufficient amounts of yolk, or none at all, subsequent to eclosion, so that survival through the first zoeal stage requires an outside food source which must be available immediately upon hatching.

Best survival was seen in the 30°C series, a somewhat surprising result because generally at this temperature the increased speed of development and the shorter intermolt duration in the larvae often appear concomitant with higher overall mortality than is seen at cooler temperatures where the development is prolonged (e.g. Wilson *et al.*, 1979). We believe that individual larval variation in development can be ruled out as a possible explanation for the observed variance in mortality in *M. coryphe* because all the zoeae in this study came from the same hatching produced by a single female. However, the fact that *M. coryphe* is more of a tropical-subtropical species (based on distributional records), rather than a eurythermic-tropical species (*sensu* Briggs, 1974) may provide some explanation. If the species and its larvae were better adapted to warmer seawater temperatures, then presumably the larvae would complete their development faster at the higher temperatures, thereby settling out from the plankton sooner.

### Description of Developmental Stages

The zoeae and megalopae of *M. coryphe*, while not completely identical to those of *M. forceps*, are sufficiently similar in most morphological characters to cause some difficulty in distinguishing between the two forms. But because an extensive description of the zoeae and megalopae of *M. forceps* is available (Wilson *et al.*, 1979), the following descriptions of larvae of *M. coryphe* will be limited to features which differ from those noted in *M. forceps*, i.e., structures not described are identical to those of *M. forceps*.

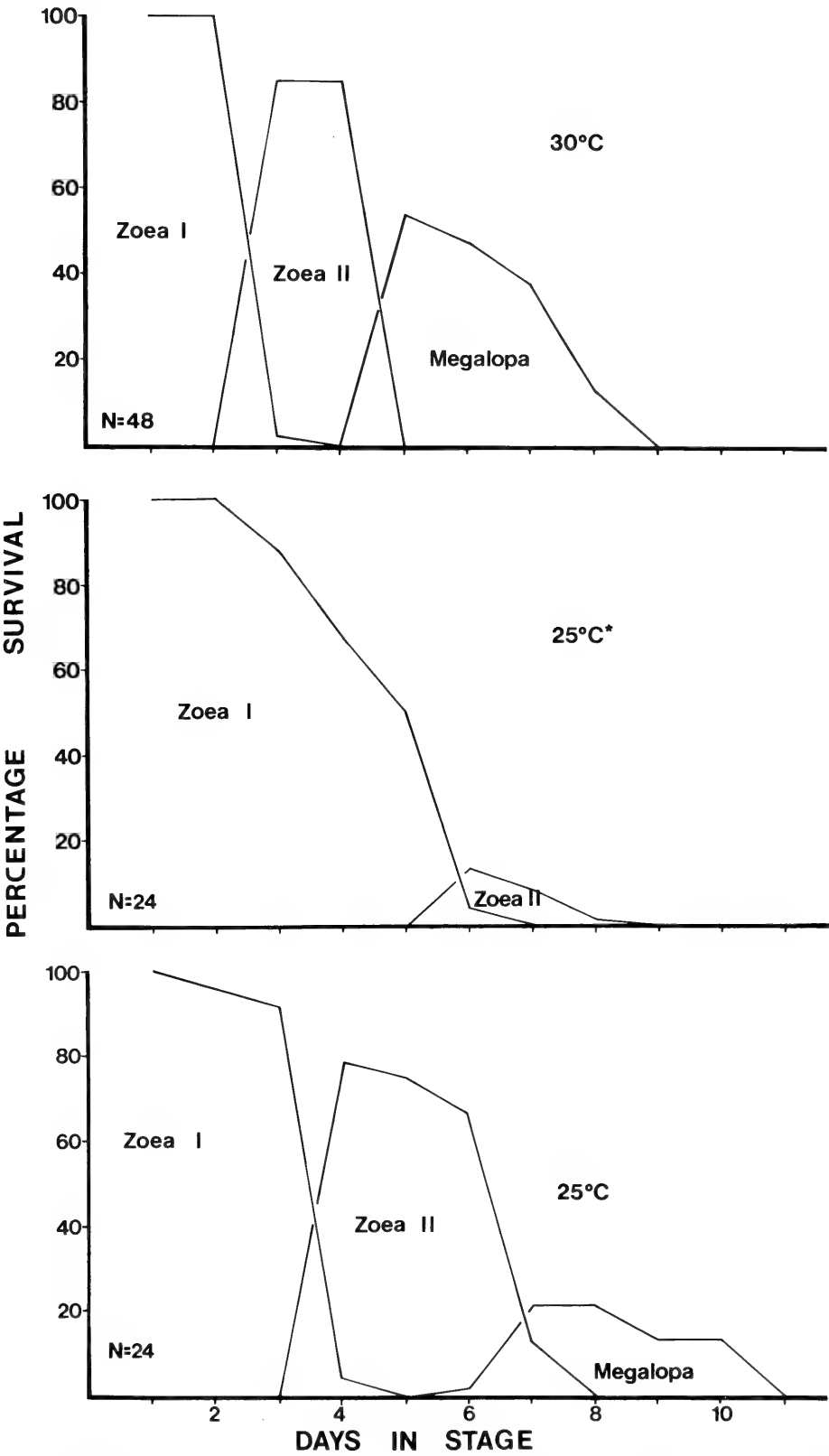


Fig. 1. Percentage survival and stage duration of *Mithrax coryphe* larvae reared under laboratory conditions. N = number of larvae cultured at each temperature; \* = larvae starved on first day at 25°C.

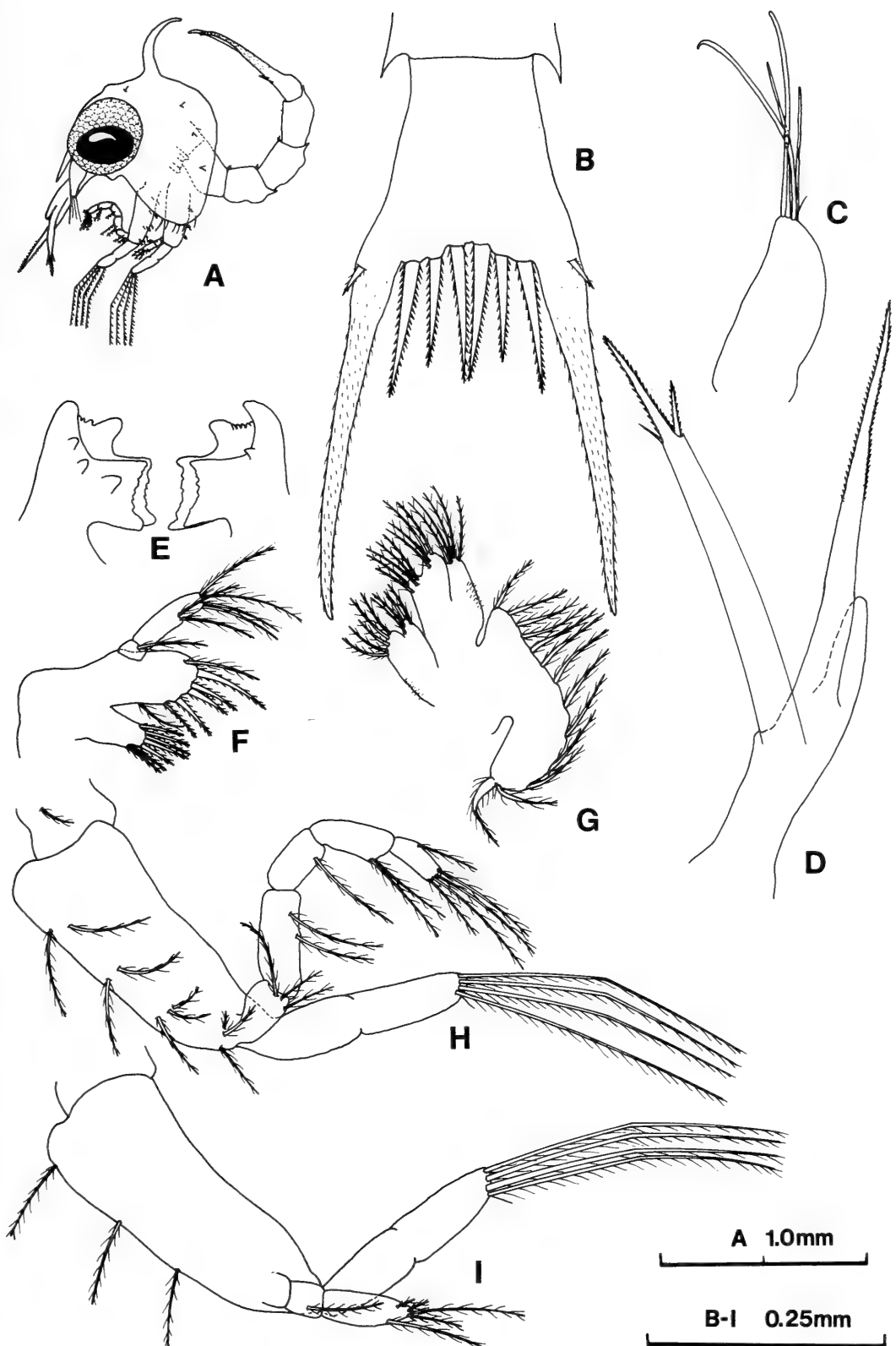


Fig. 2. *Mithrax coryphe*, first zoea: **A**, Lateral view; **B**, Telson; **C**, Antennule; **D**, Antenna; **E**, Mandibles; **F**, Maxillule; **G**, Maxilla; **H**, Maxilliped 1; **I**, Maxilliped 2.

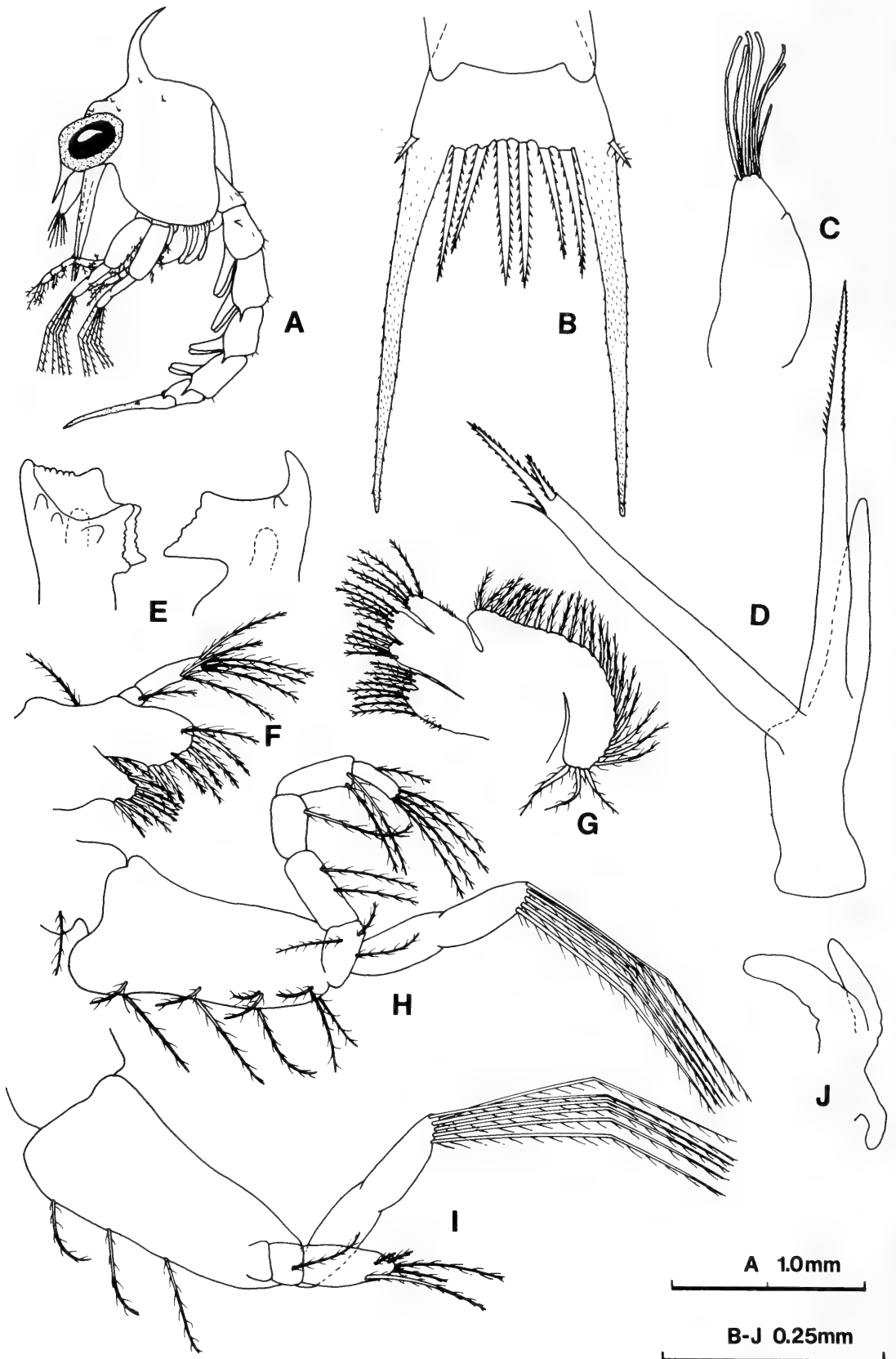


Fig. 3. *Mithrax coryphe*, second zoea: A, Lateral view; B, Telson; C, Antennule; D, Antenna; E, Mandibles; F, Maxillule; G, Maxilla; H, Maxilliped 1; I, Maxilliped 2; J, Maxilliped 3.

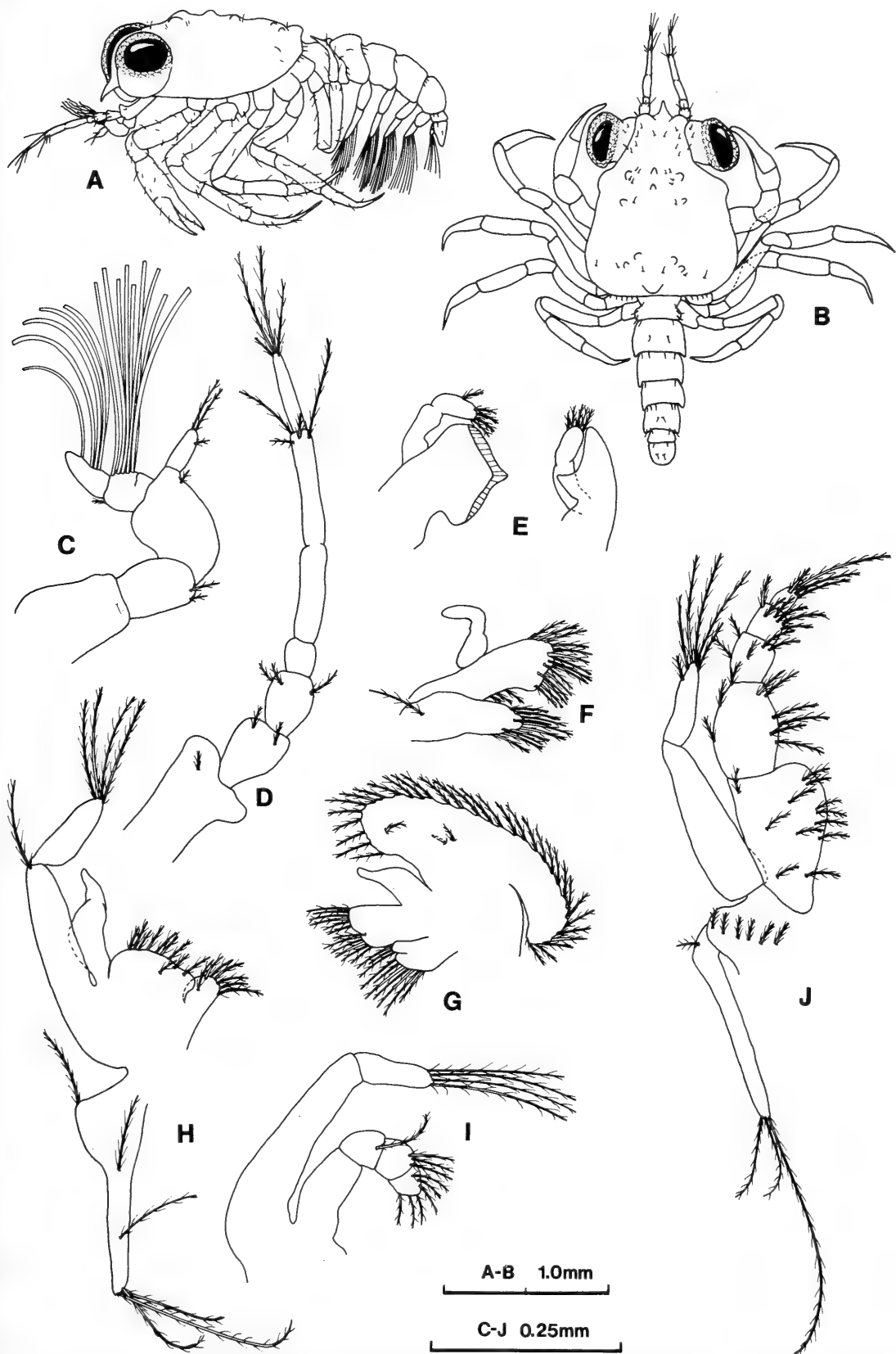


Fig. 4. *Mithrax coryphe*, megalopal sensory and feeding appendages: A, Lateral view; B, Dorsal view; C, Antennule; D, Antenna; E, Mandibles; F, Maxillule; G, Maxilla; H, Maxilliped 1; I, Maxilliped 2; J, Maxilliped 3.

In order to facilitate identification and allow comparison between the larvae of the two species, all appendages in the zoeal and megalopal stages are completely illustrated. As in *M. forceps*, the measurements of larvae are based on the arithmetic averages of the specimens examined.

*First Zoea*.—(Carapace length: 0.67 mm; 10 specimens examined).

Carapace (Fig. 2A): As in *M. forceps*, but dorsal spine slightly more recurved; rostral spine inserted at different angle than in *M. forceps*, so that antennular rod in lateral view appears ventral to plane of rostral spine; in *M. forceps* antennular rod lies in same plane as rostral spine, obscuring latter. Setation number and position identical to *M. forceps*; thoracic appendages unsegmented, visible through carapace.

Telson (Fig. 2B): Slightly wider and longer than *M. forceps*, furcae slightly longer.

Mandible (Fig. 2E): Processes slightly less robust.

Color: Differs from *M. forceps* in that the basipodites of maxillipeds 1 and 2 are orange-rose with spidery black chromatophores ventrally; in *M. forceps* maxilliped 1 is transparent, with a single black chromatophore distally at junction of endopodite, whereas maxilliped 2 is colored similarly to that of *M. coryphe*. The posterior margin of the eyes, and the dorsal carapacial spine with orange-rose hue in *M. coryphe*; uncolored in *M. forceps*.

*Second Zoea*.—(Carapace length: 0.83 mm; 10 specimens examined).

Mandibles (Fig. 3E) remain stouter in *M. coryphe*, but otherwise identical.

Maxilla (Fig. 3G) nearly identical; scaphognathite in *M. coryphe* with 25 marginal setae (24 in *M. forceps*).

Maxilliped 3 (Fig. 3J) with epipodite bud, placed as illustrated; no bud observed, but possibly overlooked in *M. forceps*.

Color: Maxilliped 1 and 2 retain first stage coloration: *M. forceps* lacks chromatophores on maxilliped 1 in this stage; abdominal somites 1–4 lime-green with orange and black chromatophores ventrally; *M. forceps* abdominal color similar to stage I.

*Megalopa*.—(Carapace length  $\times$  width: 1.15  $\times$  1.05 mm; 10 specimens examined).

Carapace (Fig. 4A, B): Generally similar to *M. forceps*, although larger in size. Differs in placement of additional tubercle on gastric region, making total of 6 (instead of 5), placed 3,1,2 (instead of 3, 2); only 4 tubercles in arch on cardiac region (instead of 5 in *M. forceps*); general carapacial setation slightly more abundant in *M. coryphe*, placed as illustrated.

Abdomen (Fig. 4A, B; Fig. 5A–C): Setation slightly different but probably not significantly so.

Antennule (Fig. 4C): Identical in form and setation (but not in aesthetasc positioning and number) to *M. forceps*; in Wilson *et al.* the aesthetascs were stated to be placed in a V, progressing distally 2,2,2,1 but this should read,



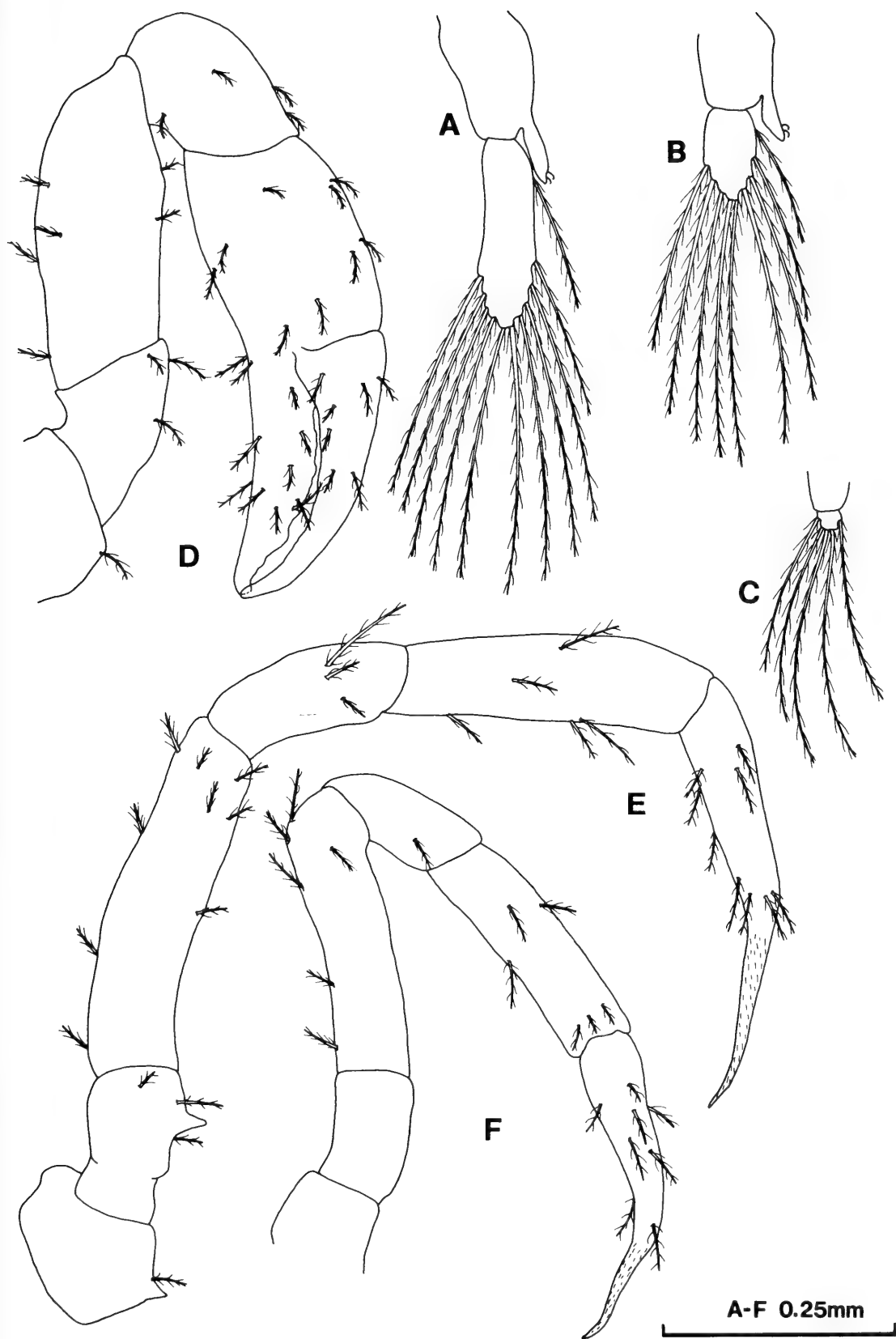


Fig. 5. *Mithrax coryphe*, megalopal locomotory appendages: A–C, Pleopods 1,4,5; D–F, Pereiopods 1,2,5.

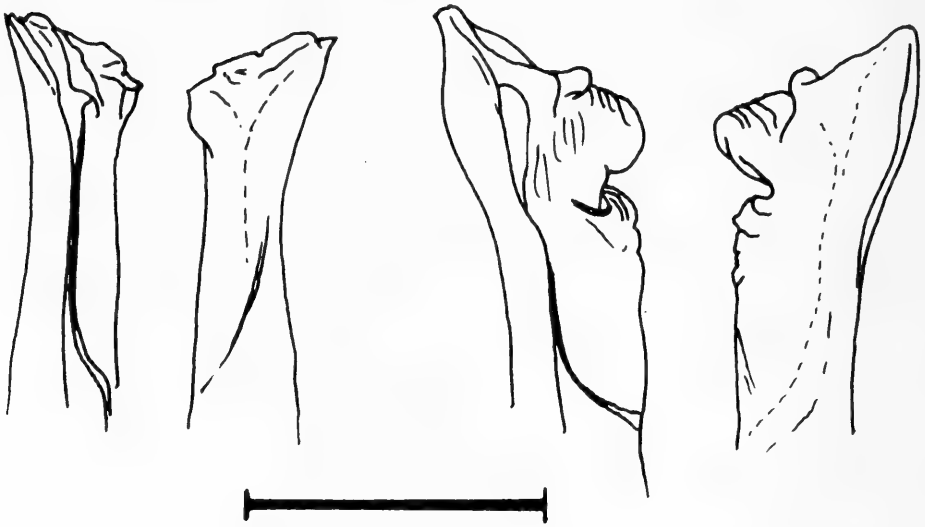


Fig. 6. Comparison of male gonopods in *Mithrax coryphe* (left) and *Mithrax forceps* (right). Sternal views on left, abdominal views on right of each figure.

progressing distally 1,2,2,2, instead; in *M. coryphe* 9 aesthetascs are positioned similarly, progressing distally 1,2,2,2,2.

Maxilla (Fig. 4G): Essentially similar; however, scaphognathite in *M. coryphe* with 29–33, usually 32 marginal setae (in *M. forceps* 26–30 marginal setae).

Maxilliped 1 (Fig. 4H): Nearly identical; epipodite differs slightly in having usually 6, sometimes 7, marginal and terminal setae.

Maxilliped 3 (Fig. 4J): Similar; variation in epipodite setation ranges from 0–2 lateral, and 2–6 terminal setae in both species, thus both overlap.

Pereiopods (Fig. 5D–F): Chelipeds essentially similar in form, varying in setation (probably not significantly); mean ratio ( $N = 5$  specimens) of movable finger to palm in *M. coryphe* = 1.37; this ratio in *M. forceps* = 1.24; walking legs more or less identical in general appearance; dactyls slightly shorter relative to propodus (0.78 in *M. coryphe*, 0.88 in *M. forceps*) on first walking leg (pereiopod 2); coxal and ischial spines present both species, figured, but inadvertently not discussed in our account of *M. forceps*; coxal spine in *M. coryphe* with 1 seta, in *M. forceps* with 2.

Color: Differs from *M. forceps*. Carapace anteriorly rose-orange, posteriorly transparent, with paired black chromatophores only dorsally; gut black interiorly; chelipeds and all walking legs rose-orange, darker on ischium, merus, carpus, lighter on propodus and dactyl. Abdominal somites 1–2 clear, 3–6 rose-orange; telson overall rose-orange, without individual chromatophore. Peripheral ommatidia of eyes reflect rose-orange, corneas dark. Rostrum, antennule and antennae clear, without chromatophores or diffuse coloration.

## Discussion

From the preceding description it is obvious that the zoeal and megalopal stages of *Mithrax coryphe* will be extremely difficult to distinguish from those of its closely related congener, *M. forceps*. Except for minor variation in appendage armature, which may eventually prove to be insignificant, the larval and postlarval stages are nearly identical. The most noticeable difference between the two species is in the coloration of live specimens on the zoeal and megalopal stages, with the two species more easily separated in the megalopal stage. In general, the carapace, telson and walking legs of *M. coryphe* are rose-orange, whereas in *M. forceps* the colors are golden-brown and greenish-gold, respectively, with nearly transparent walking legs. Postlarvae of the two species also differ in positioning and number of chromatophores, with *M. coryphe* having but a single pair dorsally on the carapace (2 pairs in *M. forceps*), no chromatophores on abdominal somites 1 and 2 (a black, and several red chromatophores, respectively, on these somites in *M. forceps*), and none on the mouthparts (several black chromatophores on the mandibles, labrum, and protopodites of maxilliped 3 in *M. forceps*).

In addition to color, *M. coryphe* differs in the megalopal stage from *M. forceps* in size (slightly larger), dorsal tuberculation on the carapace (1 more gastric, 1 less intestinal tubercle), overall carapacial setation (slightly more setose), in the number of antennular aesthetascs (9 instead of 7), and the number of marginal setae on the scaphognathite (29–33, as against 26–30 in *M. forceps*). The higher ratio of the movable finger to the palm length of the chelipeds in *M. coryphe* may prove to be of some value, although too few specimens were available to allow firm conclusions in this respect.

In a previous paper (Wilson *et al.*, 1979) we compared the larval stages of *Mithrax* (*Mithraculus*) *forceps* to the first zoea of *Mithrax* (*Mithrax*) *pleuracanthus*, and to the larval and postlarvae of *M. (Mithrax) spinosissimus*. We found very little difference between *M. forceps* and *M. pleuracanthus* on the one hand, but considerable differences between *M. forceps* and *M. spinosissimus*, on the other. This demonstrated that characters defining subgenera at the adult level may not be useful at the larval level. Moreover, the very great similarity between *M. coryphe* and *M. forceps* larvae in this study, and thus to *M. pleuracanthus* larvae (at least in the first stage), supports previous observations (e.g. Yang, 1976) that many of the species in the various majid genera in which the larvae are known show a remarkable consistency in larval characters, making them difficult to separate in the plankton. *Mithrax coryphe* thus becomes the second species in the subgenus *Mithraculus* in which the larvae appear similar to at least one species in the subgenus *Mithrax* (i.e. *M. pleuracanthus*), although differing considerably from another (*M. spinosissimus*, Provenzano and Brownell, 1977).

The great similarity exhibited by the larvae of *M. coryphe* and *M. forceps* is carried over into the adult stage to some degree. Adults of both species have oblique branchial sulci on the carapace dorsum, but are distinguished chiefly by the number and armature of the anterolateral lobes (3, bluntly rounded in *M. coryphe*; 4, spine-tipped in *M. forceps*), and whether the cheliped carpus is dorsally nodose (*M. coryphe*) or smooth (*M. forceps*). The gonopods in males of the two species show noticeable differences with that of *M. coryphe* morphologically much simpler (Fig. 6). It would appear that differentiation between the species is first observable at a very early stage, probably the megalopa, based on our studies.

### Acknowledgments

We thank Kim Allyn Wilson for her aid in collecting the ovigerous females, maintaining them in the laboratory, and for much other assistance. We gratefully acknowledge the aid of Dr. Jose A. Lozano, Director, Instituto de Investigaciones Marinas de Punta de Betín, and Mr. Hernando Nestor of the same institution for their gracious assistance and help during our stay at "Invemar" in Santa Marta, Colombia.

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# A NEW SPECIES OF *PONTOPHILUS* (CRUSTACEA: NATANTIA: CRANGONIDAE) FROM THE GULF OF MEXICO AND THE WESTERN ATLANTIC<sup>1</sup>

Mike Dardeau

**Abstract.**—*Pontophilus gorei*, a new species of caridean shrimp, is described from the Gulf of Mexico and the western Atlantic. It differs from other Gulf of Mexico species in lacking an exopod on the first pereopod and in the form of the rostrum. The synonymy of *Philocheras* with *Pontophilus* is discussed.

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In a review of the genus *Pontophilus* in the Gulf of Mexico, Pequegnat (1970) listed three species, *P. brevirostris* Smith, 1881, *P. gracilis* Smith, 1882 and *P. abyssi* Smith, 1884. Specimens discussed as *P. abyssi* later proved to be *P. talismani* Crosnier and Forest, 1973 (pers. comm., L. H. Pequegnat). Examination of specimens collected during "Project Hourglass," a biological sampling program on the continental shelf off central western Florida (see Joyce and Williams, 1969), revealed that a fourth species of *Pontophilus*, described herein, occurs in the Gulf of Mexico.

## *Pontophilus gorei*, new species

Figs. 1-4

**Material examined.**—Specimens are deposited in invertebrate collections at the U.S. National Museum of Natural History, Washington, D.C. (USNM); Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands (RMNH); Florida Department of Natural Resources Marine Research Laboratory, St. Petersburg, Florida (FSBC I); Texas A&M University, College Station, Texas (TAMU); Indian River Coastal Zone Study Reference Museum, Fort Pierce, Florida, (IRCZS); and Marine Environmental Sciences Consortium, Dauphin Island, Alabama (MESC). The abbreviation cl refers to carapace length, measured in mm from the level of the posterior margin of the orbits to the posterior margin of the carapace.

**Holotype.**—1 ovig. ♀, cl 2.5; 26°24'N, 83°22'W, 55 m; 6 Aug. 1966, trawl; USNM 172417.

**Allotype.**—1 ♂, cl 1.9; 27°37'N, 83°58'W, 55 m; 2 Aug. 1966, trawl; USNM 172418.

**Paratypes.**—West coast of Florida, off Tampa Bay: 1 ♂, cl 1.8; 2 ♀, cl 1.8, 1.7; 3 juv., cl 0.6-1.2; 27°37'N, 84°13'W, 73 m; 2 Dec. 1966, dredge; USNM 172419. 1 ♂, cl 1.8; 1 ovig. ♀, cl 2.1; 27°37'N, 84°13'W, 73 m; 2

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<sup>1</sup> Contribution No. 029 of the Marine Environmental Sciences Consortium, P.O. Box 386, Dauphin Island, Alabama 36528.

Aug. 1966, trawl; RMNH D31979. 1 ♂, cl 1.9; 27°37'N, 83°58'W, 55 m; 6 Feb. 1967, trawl; IRCZS 89:3474. 1 ovig. ♀, cl 2.1; 27°37'N, 83°28'W, 37 m; 2 June 1967, trawl; FSBC I 21454. West coast of Florida, off Sanibel Island; 1 ovig. ♀, cl 2.1; 26°24'N, 83°43'W, 73 m; 13 Oct. 1966, trawl; TAMU 2-5944. 1 ♂, cl 1.8; 26°24'N, 83°43'W, 73 m; 8 Aug. 1967, trawl; TAMU 2-5943. 1 ♂, cl 1.8; 26°24'N, 83°22'W, 55 m; 12 Oct. 1967, trawl; FSBC I 21455. 1 ovig. ♀, cl 2.0; 26°24'N, 82°58'W, 37 m; 7 Apr. 1967, dredge; IRCZS 89:3475. 1 ovig ♀, cl 2.2; 26°24'N, 82°58'W, 37 m; 6 June 1967, dredge; IRCZS 89:3476. Coast of northwest Florida, off Cape San Blas: 1 juv., cl 1.4; 28°25'N, 85°15'W, 182 m; 29 Sept. 1977, trawl; MESC. East coast of Texas, off Padre Island: 1 ♂, cl 1.9; 27°37'N, 96°33'W, 59 m; 5 June 1971, from fish stomach; TAMU 2-5942. Western Atlantic, off Georgia: 1 ♂, cl 1.9; 30°55'N, 81°18'W, 9 m; 9 Sept. 1973, small biological trawl; USNM 172420.

*Diagnosis.*—Rostrum short, extending slightly beyond cornea, with pair of lateral spines midway along length; tip spatulate with expanded rounded apex. Carapace smooth with single, strong dorsomedial spine behind rostrum; hepatic spines lacking. Merus of first pereopod with strong spine midway on flexor margin; subchelar spine simple.

*Description.*—A robust, smooth-bodied crangonid shrimp (Fig. 1a). Rostrum (Fig. 1c) short, depressed, extending slightly beyond cornea; 2 blunt lateral spines midway along length; tip spatulate, expanded club shape. Carapace (Fig. 1b) slightly depressed, smooth, with 2 very faint longitudinal carinae and single, strong, dorsomedial spine behind rostrum; suborbital spine dorsal and posterior to antennal spine; pterygostomian spine strong, equal to or extending slightly beyond eyes; a minute spine posteroventral to pterygostomian spine, directed somewhat medially; hepatic spine lacking; orbital notch present; eyes well developed.

Stylocerite (Fig. 2a) broad at base, tip acute, reaching nearly to end of basal article of antennule; antennular article 1 longer than 2, with minute distolateral spine; article 2 longer than 3; flagella overreach antennal scale, inner slightly longer than outer, both ending in a tuft of setae. Antennal blade (Fig. 2b) slightly broader proximally, tapering to subquadrate tip; lateral border of antennal scale almost straight, ending in robust distolateral spine, spine may or may not exceed antennal blade. Antennal articles 1–4 compressed; article 5 longer than combined lengths of articles 1–4, falling just short of distal margin of antennal blade; flagellum tapering to slender tip.

Mouthparts as illustrated (Figs. 2c–g).

Pereopod 1 (Fig. 3a) strong, subchelate; dactyl slender; propodus broad, width  $\frac{1}{3}$  length, with serrate spinules proximally on flexor margin, subchelar spine simple; carpus short,  $\frac{1}{5}$  length of propodus, small spine on distolateral portion of extensor margin, large medial spine ventrally, overreaching prox-

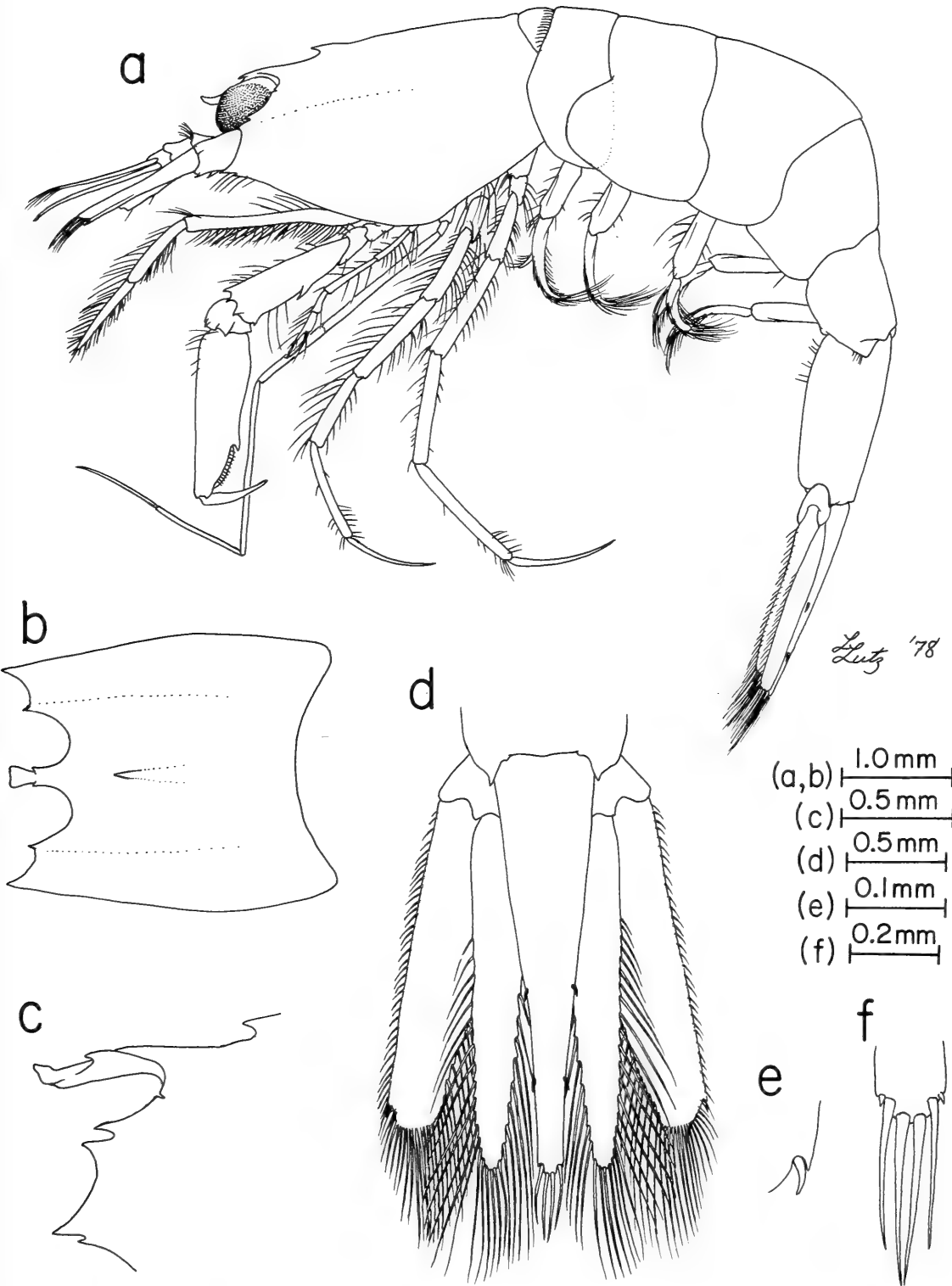


Fig. 1. *Pontophilus gorei*, paratype, ovigerous female (eggs not shown), cl 2.1, RMNH D31979: a, Whole animal, lateral view. Paratype, ovigerous female, cl 2.1, TAMU 2-5944; b, Carapace, dorsal view; c, Same, lateral view. Holotype, ovigerous female, cl 2.5, USNM 172417; d, Telson and uropods; e, Same, distolateral margin of exopod; f, Same, tip of telson.



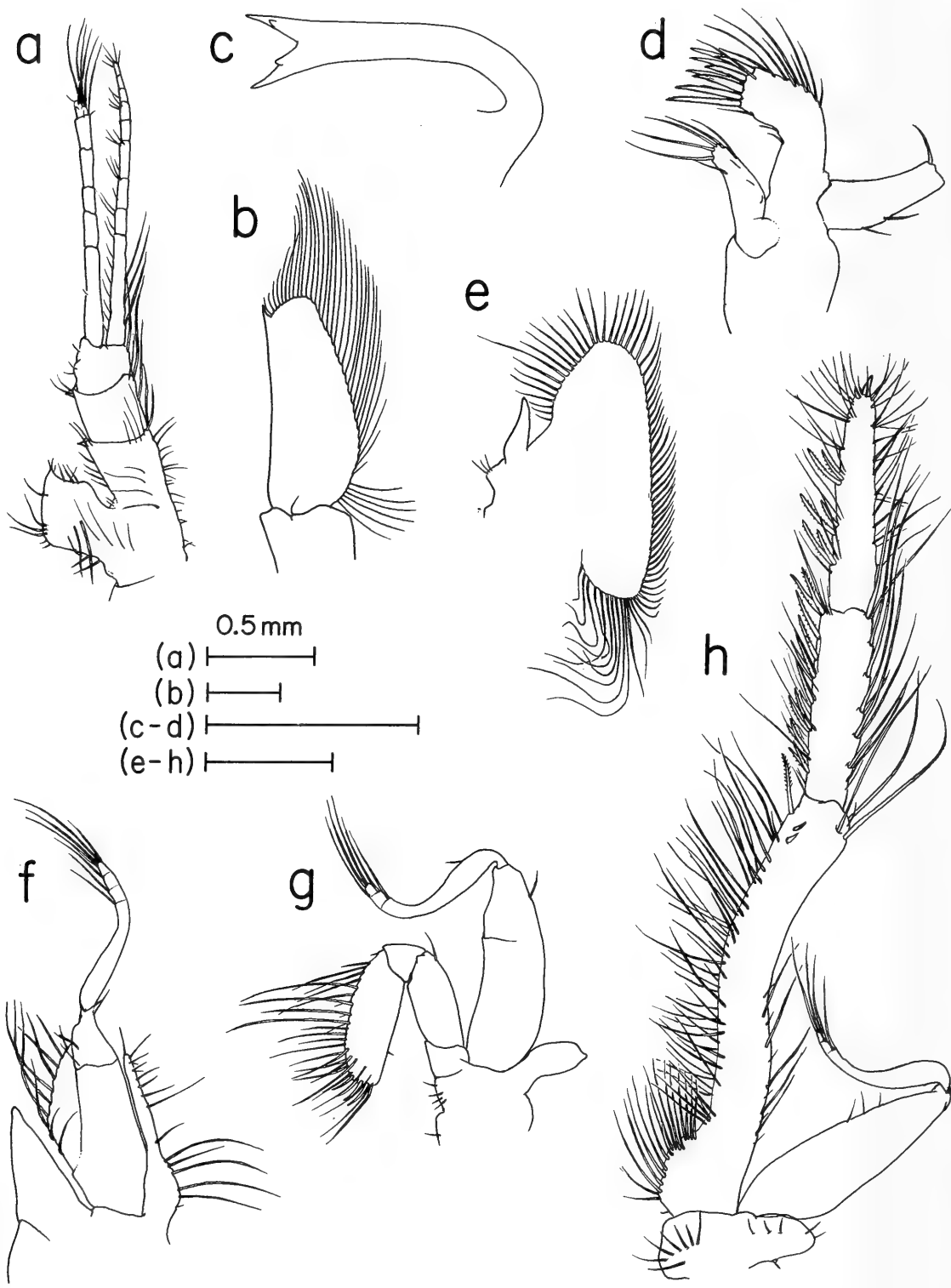


Fig. 2. *Pontophilus gorei*, holotype, ovigerous female, cl 2.5, USNM 172417: a, Left antennule; b, Left antennal scale; c, Left mandible; d, Left maxillula; e, Left maxilla; f, Right maxilliped 1; g, Left maxilliped 2; h, Left maxilliped 3.

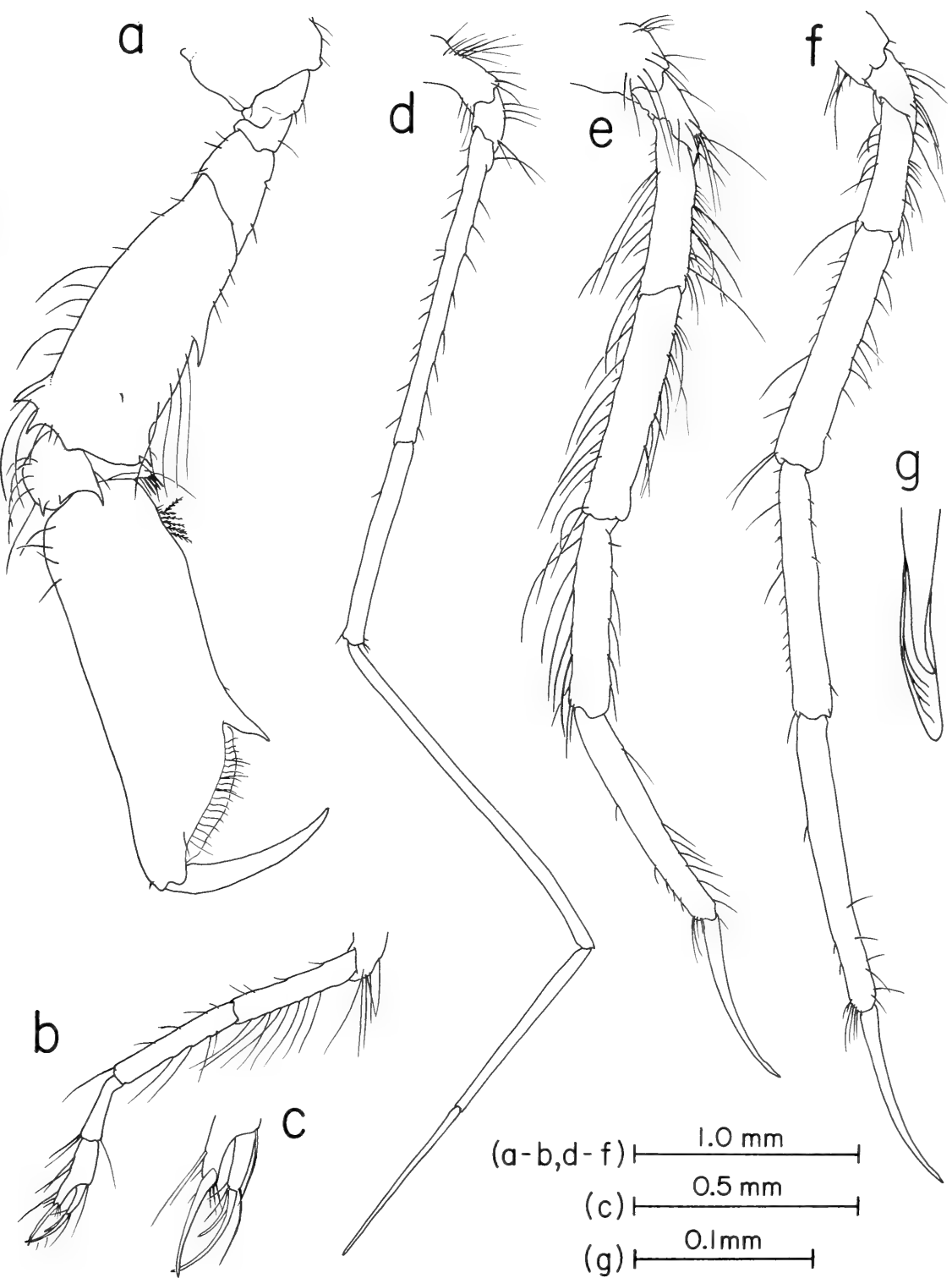


Fig. 3. *Pontophilus gorei*, holotype, ovigerous female, cl 2.5, USNM 172417: a, Left pereopod 1; b, Left pereopod 2; c, Same, dactyl and propodus; d, Left pereopod 3; e, Left pereopod 4; f, Left pereopod 5; g, Left pereopod 3, tip of dactyl.

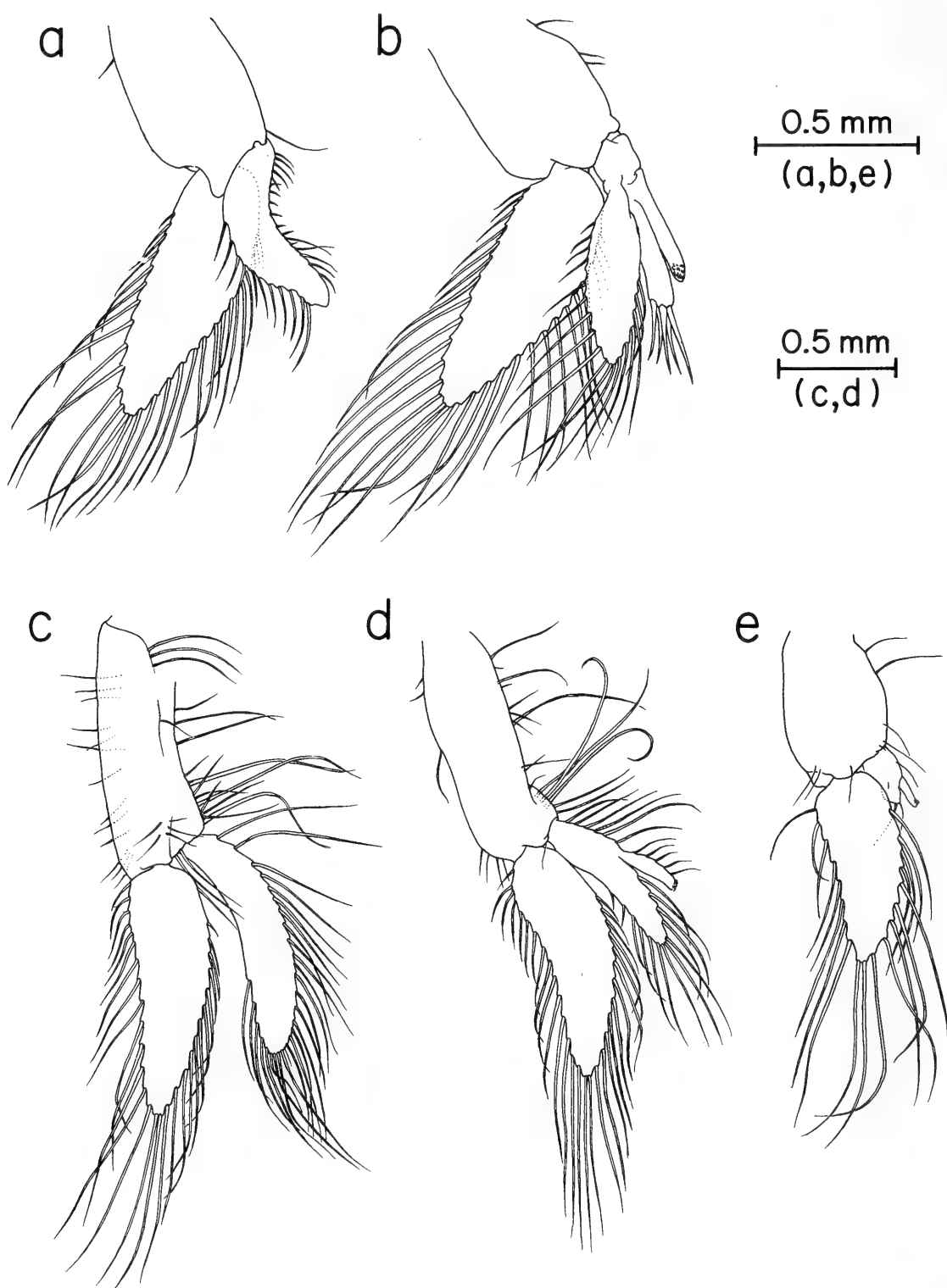


Fig. 4. *Pontophilus gorei*, allotype, male, cl 1.9, USNM 172418: a, Left pleopod 1; b, Left pleopod 2. Holotype, ovigerous female, cl 2.5, USNM 172417; c, Left pleopod 1; d, Left pleopod 2. Paratype, ovigerous female, cl 2.1, FSBC I 21454; e, Left pleopod 5.

imal portion of propodus, rounded lobe with serrate spinules on flexor margin; merus slightly shorter than propodus, bearing two spines on distal extensor margin, distal flexor margin terminating in weak spine, strong spine about midway on flexor margin; ischium and basis short, combined length  $\frac{1}{3}$  that of merus. Pereopod 2 (Fig. 3b) setose, short, reaching nearly to distal margin of merus of first; chela minute, internal margins of fingers concave, meeting only at tips (Fig. 3c). Pereopod 3 (Fig. 3d) long, slender, overreaching antennal scale by length of dactyl and propodus; dactyl with tuft of hairs on flexor margin (Fig. 3g). Pereopod 4 (Fig. 3e) shorter and stouter than third, only tip of dactyl overreaching antennal scale; dactyl with tuft of hairs on flexor margin. Pereopod 5 (Fig. 3f) reaching as far as fourth when both extended anteriorly; dactyl with tuft of hairs on flexor margin. All pereopods lacking exopods and epipods.

Six branchiae (pleurobranchs) present; inferior apices directed posteriorly.

Abdomen (Fig. 1a) tapering to long, narrow sixth segment; pleura of all segments broadly rounded ventrally; posterolateral angle of segments 1–4 bluntly rounded, that of segment 5 developed into a blunt tooth; all segments lack sculpturing.

Pleopods as illustrated (Fig. 4a–e). Endopods of each unsegmented; length ratio of latter to exopods in female holotype as follows: first  $\frac{4}{5}$ ; second,  $\frac{3}{5}$ ; third,  $\frac{1}{2}$ ; fourth,  $\frac{2}{5}$ ; fifth,  $\frac{1}{5}$ . Subapical appendix internae on pleopods 2–5. For comparisons of relative lengths in the sexes see remarks below.

Telson (Fig. 1d, f) long, narrow, truncate terminally, bearing 3 pairs of terminal spines; lateral pair minute, intermediate pair  $\frac{4}{5}$  length of mesial pair; 2 pairs of minute dorsal spines on lateral margins at about  $\frac{1}{2}$  and  $\frac{4}{5}$  length. Uropod long, narrow, setose; endopod slightly overreaching telson; exopod falling just short of telson, lateral margin straight, terminating in fixed tooth proximal to movable spine at distal end of margin (Fig. 1e).

Eggs 0.3–0.5 mm in diameter, depending on development.

*Type-locality*.—The ovigerous female holotype was taken 135 km due west of Sanibel Island Light in the eastern Gulf of Mexico.

*Distribution*.—Most specimens were from the two “Project Hourglass” transects over the continental shelf of the west coast of Florida, off Sanibel Island and Tampa Bay. A single specimen was taken 167 km off the north-west coast of Florida in the central Gulf. The single specimen from a fish stomach (*Prionotus rubio*) from the Texas coast extends the range of this species into the western Gulf of Mexico. A single male specimen captured off Georgia represents the only record for this species from the east coast of the United States. Although this specimen was taken in 9 m, all Gulf specimens were taken at greater depths ranging from 37 to 182 m.

*Etymology.*—This species is named in honor of Dr. Robert H. Gore in recognition of his many contributions to the field of carcinology and his unselfish aid to others in the field.

*Remarks.*—The outer flagella of the antennules of males are broad, thickened and distinctly shorter than the inner flagella. Outer flagella of females are only slightly shorter and thicker than the inner flagella (Fig. 2a).

Sexual dimorphism is also exhibited in the form and development of the pleopods. Margins of the endopod of the first pleopod of males (Fig. 4a) are sinuous, terminating about  $\frac{3}{4}$  the length of the exopod, but in females (Fig. 4c) the margins are evenly curved and the tip is more lobate, the latter reaching about  $\frac{4}{5}$  the length of the exopod. The second pleopod of males bear a well developed appendix masculina and an appendix interna (Fig. 4b); females bear only an appendix interna (Fig. 4d). The relative lengths of the endopods of pleopods 2–4 of both males and females are somewhat variable but generally decrease in size sequentially from  $\frac{3}{5}$  to  $\frac{1}{4}$  the lengths of the exopods in females and from  $\frac{4}{5}$  to  $\frac{3}{5}$  the lengths of the exopods in the males. The appendix interna arises near the base of the endopod in males but has a more distal origin in females. The endopod of the fifth pleopod of adult males is relatively long, varying from  $\frac{4}{5}$  to  $\frac{1}{2}$  the length of the exopod; the appendix interna is in the usual basal position. In females, however, the appendix interna is positioned subapically on the fifth pleopod, and may extend beyond the endopod; the endopod is reduced, never exceeding  $\frac{1}{4}$  the length of the exopod (Fig. 4e).

Relative lengths of the endopods are a function of size as well as sex. Ovigerous females, from 1.8 to 2.2 mm carapace length (cl), vary little. In non-ovigerous females (recognizable at 1.5 mm cl), relative lengths of the endopods increase in specimens of up to 1.8 mm cl, whereupon the relative lengths remain consistent. Between 1.5 and 1.7 mm cl, the appendix interna may be missing on the posterior pairs of pleopods. The appendix masculina of the male is present at 1.5 mm cl, although it may be somewhat reduced. Relative lengths of endopods show the same progressive increase as in females but continue to increase in specimens up to 2.2 mm cl. Juveniles, less than 1.4 mm cl, may or may not possess an appendix interna.

*Comparisons.*—The strong spine on the flexor margin of the first pereopod easily distinguishes this species from all other western Atlantic species of *Pontophilus*. *P. dimorphus* Fujino and Miyake, 1971 from Sagami Bay, Japan, seems to be the only described species with such a spine. A similar spine is figured on the extensor margin by Bate (1888) for *P. gracilis* Bate, 1888 (= *P. challenger* Ortmann, 1893) but Calman (1939) remarks in a footnote that none of the type-series of *P. challenger* possess this spine. Although *P. dimorphus*, like *P. gorei*, lacks an exopod on the first pereopod the extensive spination on the carapace does not substantiate a close relationship.

Table 1.—Generic characters of *Pontophilus* and *Philocheras* exhibited by Gulf of Mexico specimens (adapted from Kemp, 1911).

	Characters typical of <i>Pontophilus</i>						Characters typical of <i>Philocheras</i>					
	Stylocerite acute	Exopod on pereopod 1	Pereopod 2 not reaching distal end of merus of first	Endopod of pleopods 2-5 only a little shorter than exopod	Endopod of pleopods unsegmented	Appendix interna present	Stylocerite rounded	Exopod lacking on pereopod 1	Pereopod 2 reaching distal end of carpus of first	Endopod of pleopods 2-5 little more than half length of exopod	Endopod of pleopods segmented	Appendix interna absent
<i>Pontophilus gorei</i> n. sp.	x	—	x	♂	x	x	—	x	—	♀	—	—
<i>Pontophilus brevirostris</i> Smith, 1881	x	x	x	x	x	x	—	—	—	—	—	—
<i>Pontophilus gracilis</i> Smith, 1882	x	x	x	x	x	x	—	—	—	—	—	—
<i>Pontophilus talismani</i> Crosnier & Forest, 1973	x	x	x	x	x	x	—	—	—	—	—	—

The present species is most closely related to a small group of extra-American species which lack an exopod on pereopod 1, possess a single spine in the dorsal midline of the carapace and lack hepatic spines. These species, however—*Pontophilus monacanthus* Holthuis, 1961 from Turkey, *P. opici* Crosnier, 1971 from West Africa, *P. megalochair* (Stebbing, 1915) from South Africa and *P. hendersoni* Kemp, 1915 from South Africa and India—all possess a bifid subchelar spine while that of *P. gorei* is simple. *P. gorei* also differs from each in the form of the rostrum which is blunt, expanded at the apex and possesses strong lateral spines midway along its length.

*Discussion.*—Kemp (1911), using data on intergrades of the characters shown in Table 1, concluded that in Asiatic waters it was impossible to distinguish between the genera *Pontophilus* and *Philocheras*. More recently European workers (Zariquiey Álvarez, 1968; Lagardère, 1971), using the same characters, regarded the two genera as distinct in Atlantic and Mediterranean waters. In view of the ambiguous nature of some of the features of *P. gorei*, expressed in Table 1, we can only follow Kemp (1911) and consider *Philocheras* Stebbing, 1900 to be a synonym of *Pontophilus* Leach, 1817. As Kemp (1916) recognized, several natural groupings exist and one solution to the systematic confusion in this unwieldy genus may lie in the recognition of several genera.

Acknowledgments

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specimens and for their unending patience. Dr. Thomas S. Hopkins (under BLM Contract AA550-CT7-34), Dauphin Island Sea Lab, and Dr. John N. Kraeuter, Virginia Institute of Marine Science, also contributed specimens. I am particularly indebted to Dr. Linda H. Pequegnat, Texas A&M University, for the loan of comparative material and to Dr. L. B. Holthuis, Rijksmuseum van Natuurlijke Historie, for comments on the nature of the *Pontophilus/Philocheras* problem. Finally, I thank Dr. Richard W. Heard for his guidance, Ms. Linda B. Lutz for the illustrations and Dr. F. A. Chace, Jr. for reviewing the manuscript.

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## FOUR NEW SPECIES OF *RENOCILA* (ISOPODA: CYMOTHOIDAE), THE FIRST REPORTED FROM THE NEW WORLD

Ernest H. Williams, Jr. and Lucy Bunkley Williams

*Abstract.*—*Renocila colini* sp. n. is described from the flamefish, *Apogon maculatus* (Poey), and the belted cardinal fish, *Apogon townsendi* (Breder), from Mona Island, Puerto Rico; *R. waldneri* sp. n. from the harlequin bass, *Serranus tigrinus* (Bloch), from La Caleta, near Santo Domingo, Dominican Republic; *R. bowmani* sp. n. from the harlequin bass from Saona Island, Dominican Republic; and *R. thresherorum* sp. n. from *Apogon retrosella* (Gill) from Loreto, Baja California Sur, Mexico.

Limited data suggests that members of this genus possess extremely restricted geographic ranges, high rates of infestation, and a high degree of host specificity. Oostegites of *Renocila colini*, and possibly other species in the genus, are formed during a single molt.

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### Introduction

The genus *Renocila* is represented by 5 known species, *R. dubia* (Nierstrasz, 1931) Barnard, 1936; *R. heterozota* Bowman and Mariscal, 1968; *R. indica* Schioedte and Meinert, 1884; *R. ovata* Miers, 1880; and *R. periphthalma* Stebbing, 1900, from the Indopacific Region. Four new species of the genus are described from the West Indies and the American Pacific Regions.

### Materials and Methods

Parasitized cardinalfishes were located at night using underwater lights and scuba. They were collected with quinaldine or microprong spears propelled by miniature Hawaiian slings. Later in the work, fishes were captured by forcing them into plastic bags with the face of underwater lights. Parasitized harlequin bass were collected during the day with a macroprong spear and an elastic band speargun or with a microprong spear. Hosts were immediately sealed in individual plastic bags, and stored in a dive bag for no longer than 60 minutes. Location of isopods on each host was recorded on an underwater slate.

Hosts were weighed to the nearest 0.1 g, measured for standard and total lengths to the nearest mm, and examined for damage associated with the isopod under 10× power of a dissecting microscope. Isopods were measured



for total length and maximum width to the nearest 0.1 mm, while alive. They were preserved in 70% ethanol. Eggs and larvae were removed from female isopods, counted, and a random sample of 10 measured for total length and maximum width to the nearest 0.01 mm. Mouthparts and appendages were mounted in glycerine jelly. Drawings of appendages were made with the aid of a Bausch and Lomb Trisymplex microprojector, whole specimens were drawn from projections of 35 mm slides made with a Nikon F2, 55 mm Nikon macro lens and bellows. Telsons of the illustrated species were drawn in a natural or some what depressed position; therefore, the length of telsons in the dorsal views do not represent the actual total lengths.

*Renocila colini*, sp. n.

Figs. 1–27 and 105

*Type-host and locality (date and depth).*—Flamefish, *Apogon maculatus* (Poey), Carmelita, Mona Island (23 April 1976) (10 m.).

*Additional hosts and localities (date and depths).*—Belted cardinal fish, *Apogon townsendi* (Breder), east of Playa Carabinero, Mona Island (20 April 1976) (15 m); Playa Sardinera, Mona Island (22 April 1976) (15 m); flamefish, Playa Carabinero (27 December 1975) (30 m), east of Playa Carabinero (20 April 1976) (15 m), Playa Sardinera (21, 22 and 23 April 1976; 25 May 1977) (17 m); and Carmelita (23 April 1976) (10 m).

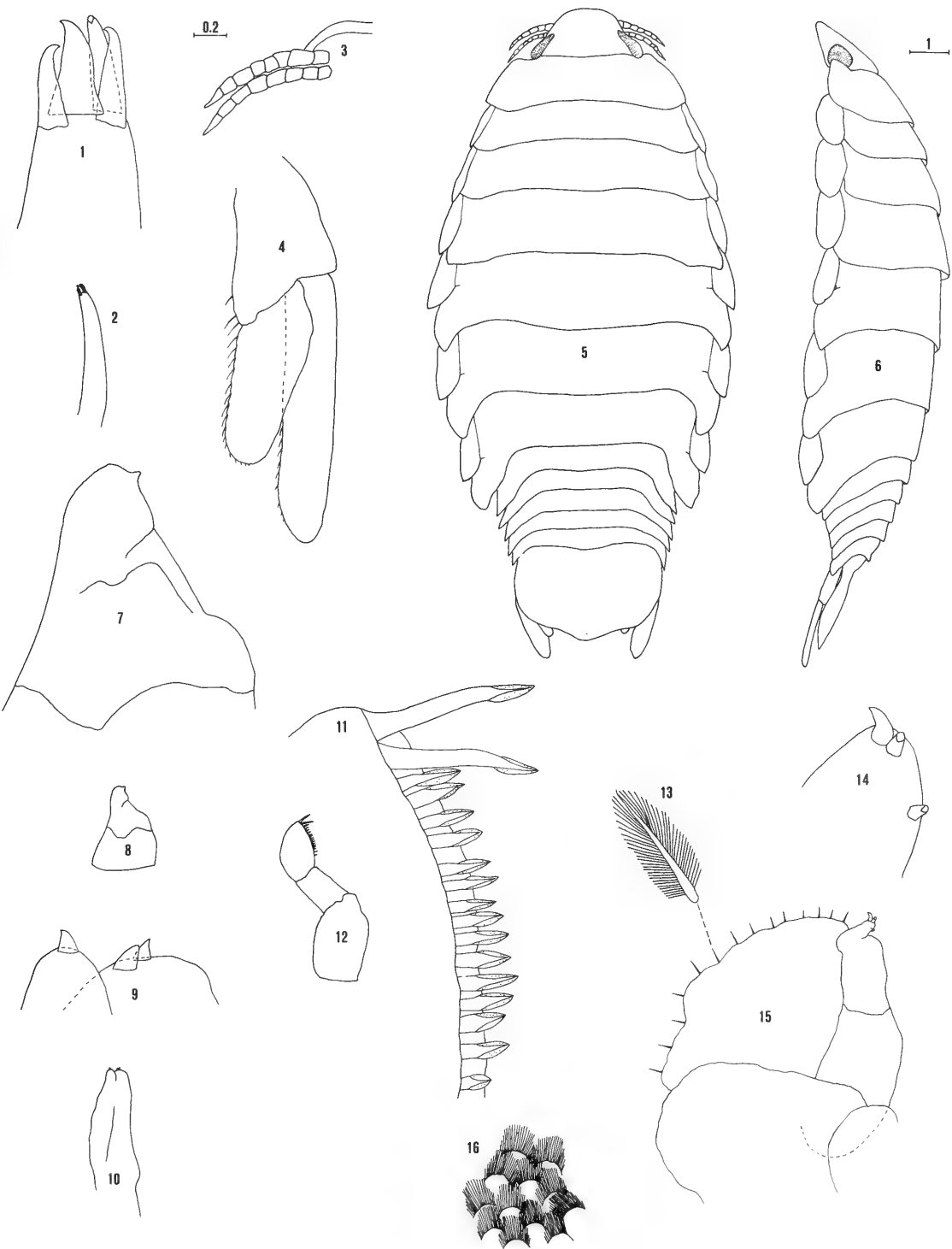
*Location.*—Male-female pair or occasionally female, male, or transitional specimens attached to dorsal surface along side of the dorsal fin. Male anterior to female (Fig. 105).

*Specimens studied.*—42 (all type-material).

*Type-specimens.*—Holotype (female), USNM 173920; allotype (associated male) USNM 173921; 8 paratypes, USNM 173922–25; 32 paratypes in authors' collection.

*Diagnosis.*—Anterior margin of head inflexed, not produced into lobe between bases of antennae 1. Posteroventral angle of pereonites 5–7 produced, that of pereonite 7 overlapping only pleonite 1. Telson  $\frac{1}{7}$  to  $\frac{1}{2}$  wider than long. Antennae 1 slightly broader and slightly shorter than antennae 2. Pereopods 1–3 without swelling in dactyl and without lobe at posterodistal corners of basis. Pereopods 6–7 subequal in length. Inner ramus of uropod more than half as long as outer ramus.

*Further details.*—Antennae 1 8-merous. Antennae 2 8-merous. First segment of mandibular palp expanded, 3rd segment with 7 to 15 stout setae with broad distal ends along outer margin, and 2 similar, but longer apical setae; 2nd segment with 3 closely spaced setae on inner margin similar to marginal setae of 3rd segment. Incisor process of mandible broad pointed with a fine tip. Maxilla 1 with 4 recurved apical spines. Distal lobes of



Figs. 1–16. *Renocila colini*, female: 1, Apex of maxilla 1; 2, Maxilla 1; 3, Antennae and anterior margin of head, ventral; 4, Right uropod, dorsal; 5, Dorsal view; 6, Lateral view; 7, Apex of mandible; 8, Mandible; 9, Apex of maxilla 2; 10, Maxilla 2; 11, Apex of 3rd segment, left mandibular palp; 12, Left mandibular palp; 13, Seta of maxilliped; 14, Apex of palp, maxilliped; 15, Maxilliped; 16, Scales on maxilla 2. (Whole mouthparts and pereopods 28×; enlargements of portions of mouthparts 280×.) (Scales in mm.)

maxilla 2 each with 2 blunt spines, occasionally 1 (Fig. 9). Distal segment of maxillipedal palp with 3 stout recurved spines.

Penis lobes of male separate. Appendix masculina of male pleopod 2 linear, with unmodified apex (terminal setae on apex of juvenile male). Females possess a reduced appendix masculina 33 to 67% the length found in the male.

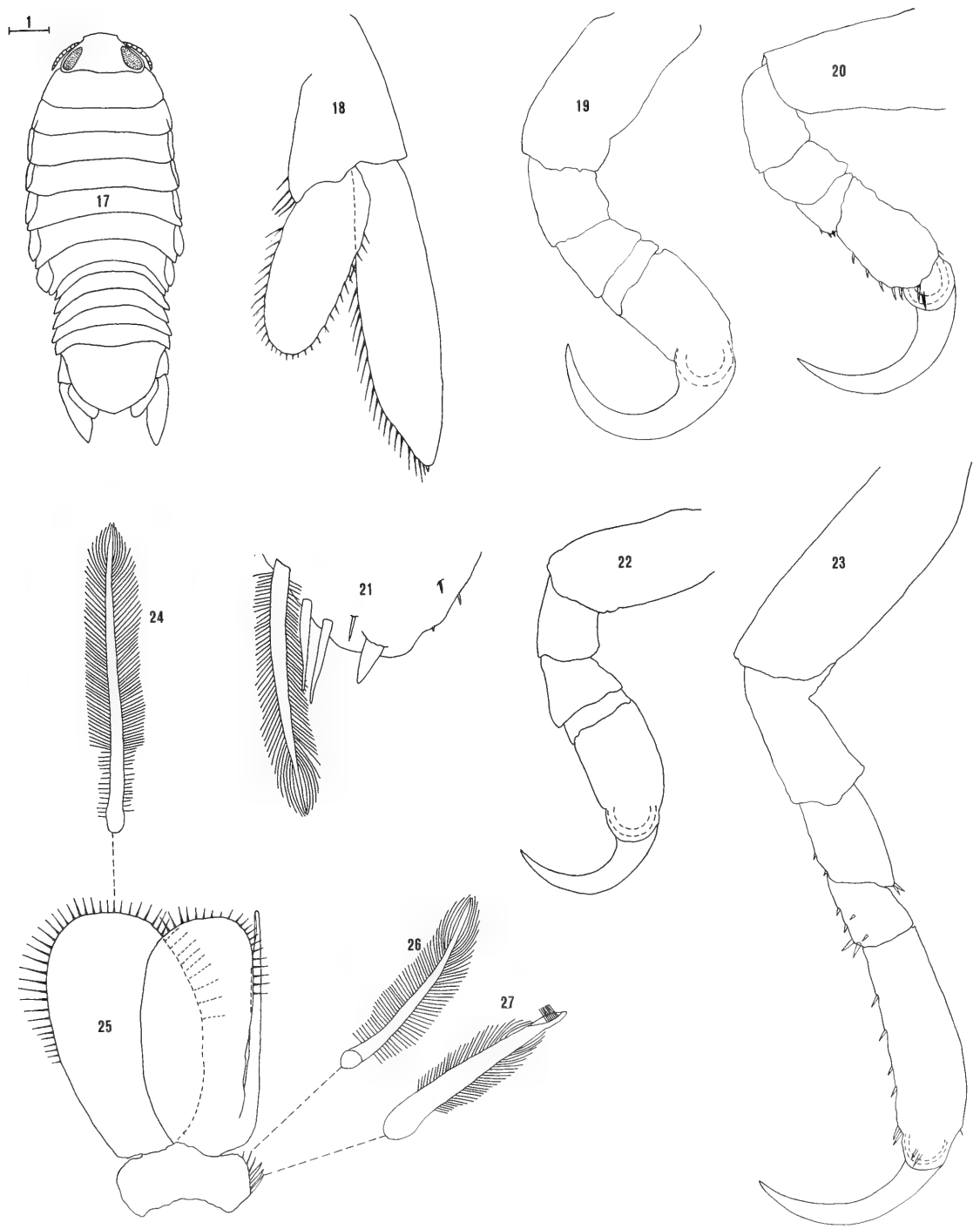
*Color*.—Dorsal and appendages of living specimens uniform yellowish brown.

*Variation*.—Posteroventral angle of pereonite 4 occasionally slightly produced. Pereonite 7 occasionally extends slightly beyond pleonite 1. Telson averages  $\frac{1}{3}$  wider than long with a range of  $\frac{1}{7}$  to  $\frac{1}{2}$ . Antennae 1 occasionally equal in length to antennae 2, but occasionally much longer than antennae 2.

*Remarks*.—Of the 42 specimens of *Renocila colini* collected from 29 hosts, 20 were females, 18 males, and 4 transitionals; no juveniles were collected. Nine females with oostegites were 12.0 to 17.5 mm in length, mean 16.2 mm; 5.9 to 9.0 mm in width, mean 8.0; lacked penis lobes; and possessed reduced appendix masculina ranging from approximately 42 to 67% of the length found in the male. Eleven females lacking oostegites were 10.2 to 16.2 mm long, mean 13.2 mm; 4.5 to 9.0 mm in width, mean 6.6 mm; lacked penis lobes; and possessed reduced appendix masculina ranging from approximately 33 to 67% the length found in the male. Four transitionals with reduced penis lobes were 8.0 to 13.0 mm long, mean 10.7 mm; 4.5 to 5.5 mm in width, mean 4.8 mm, and possessed reduced appendix masculina ranging from approximately 67 to 75% of the length found in male. Males were 7.5 to 13.0 mm long, mean 9.9 mm, and 2.8 to 4.5 mm in width, mean 3.6 mm.

Only 1 of the 9 females with oostegites possessed an empty brood pouch. Numbers of eggs or young in the other females varied from 46 to 175 and averaged 115. The smallest and apparently least developed brood numbered 157 and were spherical to subspherical embryos 0.83 to 1.08 mm (averaging 0.95 mm) long by 0.74 to 0.88 mm (averaging 0.81 mm) wide. Broods of 3 females, numbering 46 to 152, were oblong embryos 0.99 to 1.18 mm (averaging 1.08 mm) long by 0.81 to 0.91 mm (averaging 0.89 mm) wide. One female contained 74 oblong embryos with a cephalic end formed, but not possessing eyes, 1.22 to 1.37 mm (averaging 1.27 mm) long by 0.74 to 0.83 mm (averaging 0.78 mm) wide. Broods of 3 females, numbering 94 to 175, were larvae with 6 pereonites and a loose cuticle, apparently ready to molt, 2.60 to 2.78 mm (averaging 2.69 mm) long by 0.86 to 0.95 mm (averaging 0.93 mm) wide.

The average femininity index (Legrand, 1951-width/length  $\times$  100) of the males associated with females ( $N = 13$ ) is 36.7; males not associated with



Figs. 17–27. *Renocila colini*: 17, Dorsal view, male; 18, Right uropod, male; 19, Pereopod 1, female; 20, Pereopod 7, female; 21, Distal end, outer ramus of uropod, male; 22, Pereopod 1, male; 23, Pereopod 7, male; 24, Seta of pleopod 2, male; 25, Pleopod 2, male; 26–27, Setae of pleopod 2, male. (Whole mouthparts and pereopods 28×; enlargements of portions of mouthparts 280×.) (Scale in mm.)

females (N = 5) 33.6; transitionals (N = 4) 46.4; females not associated with males (N = 7) 48.8; females associated with males (N = 13) 50.5.

The 27 infested flamefish were 3.8 to 7.1 cm in standard length, and averaged 5.1. Male-female pairs of isopods were equally abundant on all sizes of hosts. The belted cardinalfish infested were 4.0 and 6.3 cm in standard length. Damage to the host was minor to unnoticeable, occasionally occurring at the attachment point of the female isopod.

The position of the male and female on the host as discussed above and shown in Figure 105 was consistent in all the specimens collected and in numerous other specimens observed in the field. Pairs or individual isopods occurred as frequently on the left as on the right side of the dorsal fin. Charles Arneson (pers. comm.) observed a cardinalfish at Mona Island which possessed 3 *Renocila* sp. on 1 side of the dorsal fin and 2 on the opposite side. Unfortunately this specimen was not captured.

Four abnormalities were noted. The first left pleopod of a female with oostegites was reduced to less than  $\frac{1}{2}$  normal size; and the first right pleopod of female lacking oostegites was reduced to approximately  $\frac{1}{3}$  normal size. The left pereopod 7 of a female lacking oostegites was reduced to approximately  $\frac{1}{5}$  of the size of the normal right pereopod 7. The right uropod of a transitional specimen was reduced and did not extend to the posterior end of the telson; the outer ramus was the most reduced portion, the basis the least reduced portion.

All females with oostegites were associated with males, which suggests either the presence of a male is necessary to form oostegites in the female, or the presence or process of producing oostegites attracts males. However, the one female in the process of molting with  $\frac{1}{2}$  of the oostegites exposed was associated with a male. Oostegite formation seems to be independent of the size of the female as some of the largest and smallest collected lacked these structures.

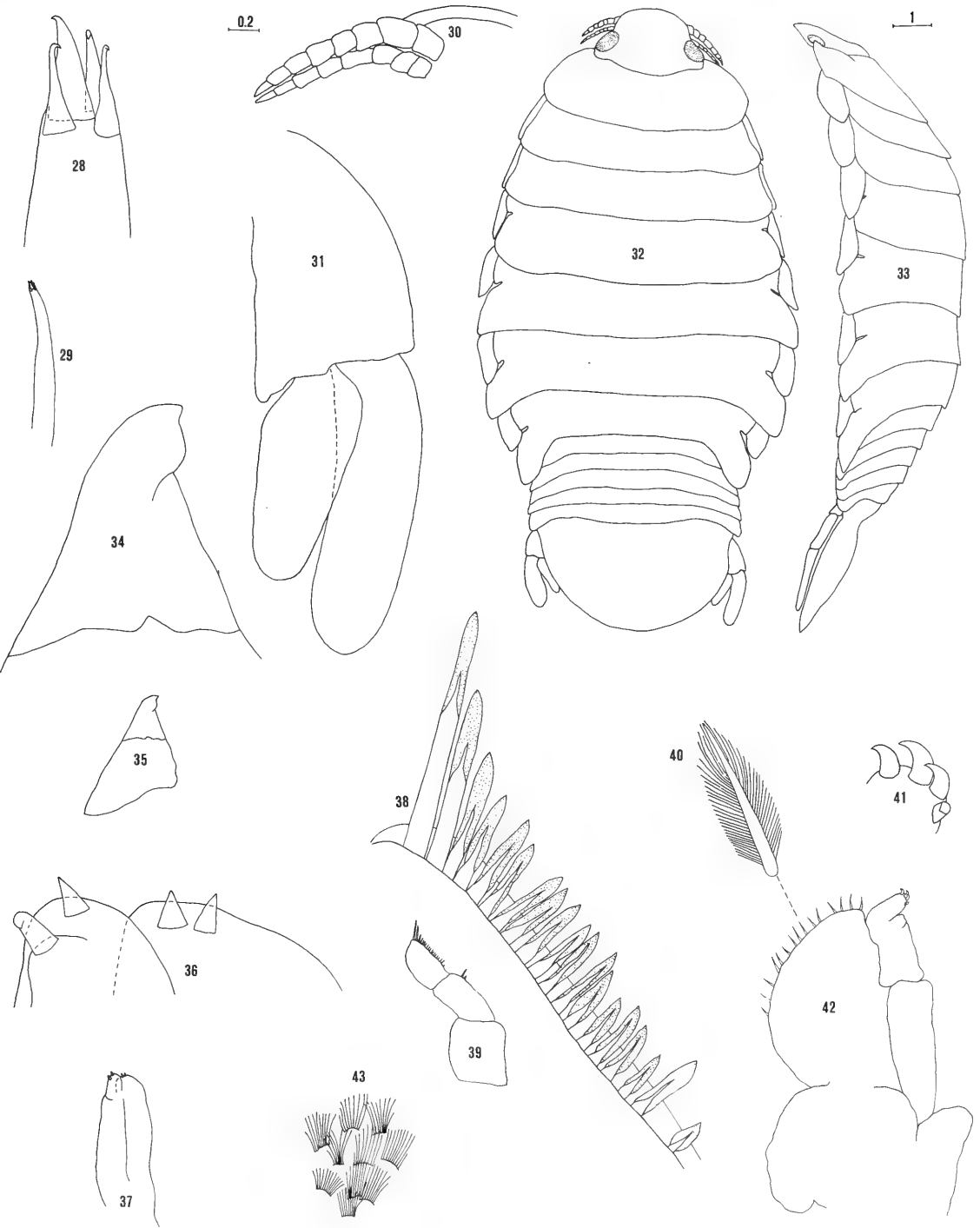
The prolonging of the male stage by the associated female as noted in *Anilocra physodes* (Linnaeus) by Legrand (1951) and in *Lironeca puhi* Bowman by Bowman (1959), apparently occurs in *Renocila colini*. Some of the males associated with females were longer (lengths 7.5 to 13.0 mm) than any of singly occurring males (lengths 8.0 to 10.1 mm); which indicates males associated with females tend to retain male characters to a larger size than non-associated males.

The specific name is in honor of the discoverer and collector of the first specimen of this isopod, Dr. Patrick L. Colin.

*Renocila waldneri*, sp. n.

Figs. 28–52 and 106

*Type-host and locality (date and depth).*—Harlequin bass, *Serranus tigrinus* (Bloch), La Caleta, near airport, Santo Domingo, Dominican Republic (23 November 1978 and 17 May 1979) (17 m).



Figs. 28–43. *Renocila waldneri*, female holotype: 28, Apex of maxilla 1; 29, Maxilla 1; 30, Antennae and anterior margin of head, ventral; 31, Right uropod, dorsal; 32, Dorsal view; 33, Lateral view; 34, Apex of mandible; 35, Mandible; 36, Apex of maxilla 2; 37, Maxilla 2; 38, Apex of 3rd segment, left mandibular palp; 39, Left mandibular palp; 40, Seta of maxilliped; 41, Apex of palp, maxilliped; 42, Maxilliped; 43, Scales on maxilla 2. (Whole mouthparts and pereopods 28×; enlargements of mouthparts 280×.) (Scales in mm.)

*Location*.—Male-female pair or single male, transitional, or female specimens attached to dorsal surface alongside of the dorsal fin. Male in contact with female along lower anterior side (Fig. 106).

*Specimens studied*.—18 (all type material).

*Type-specimens*.—Holotype (female) USNM 173926; allotype (associated male) USNM 173927; 8 paratypes USNM 173928–32; 8 paratypes in authors' collection.

*Diagnosis*.—Anterior margin of head inflexed, not produced into lobe between bases of antennae 1. Posteroventral angle of pereonite 5 moderately produced, of pereonites 6–7 produced, that of pereonite 7 overlapping pleonites 1 and 2. Telson  $\frac{1}{3}$  to  $\frac{2}{3}$  wider than long. Antennae 1 much broader and slightly shorter than or equal in length to antennae 2. Pereopods 1–3 without swelling in dactyl and without lobe at posterodistal corner of basis. Pereopods 6–7 subequal in length. Outer ramus of uropod slightly longer than inner ramus.

*Further details*.—Antennae 1 8-merous. Antennae 2 8-merous. First segment of mandibular palp expanded; 3rd segment with 16 stout setae with broad distal ends along outer margin, and 3 similar, but longer apical setae; 2nd segment with 3 closely spaced setae on outer margin similar to longer apical seta of 3rd segment. Incisor process of mandible broad pointed. Maxilla 1 with 4 recurved apical spines. Dorsal lobes of maxilla 2 each with 2 blunt spines. Distal segment of maxillipedal palp with 3 stout recurved spines occasionally 4 (Fig. 41).

Penis lobes of male separate. Appendix masculina of male pleopod 2 linear, with unmodified apex, arising near base of endopod, about as long as endopod. Female possessed a reduced appendix masculina 33 to 67% the length found in the male.

*Color*.—Dorsal of living specimens uniform brown, appendages yellowish brown.

*Variation*.—Posteroventral angle of pereonite 5 occasionally not produced. Telson averages  $\frac{1}{2}$  wider than long with a range of  $\frac{1}{3}$  to  $\frac{2}{3}$ .

*Remarks*.—Of the 18 specimens of *Renocila waldneri* collected from 12 hosts, 9 were females, 8 males, and 1 a transitional; no juveniles were collected. Four females with oostegites were 15.3 to 19.3 mm in length mean 17.4 mm; 8.0 to 9.3 mm in width, mean 8.6 mm; lacked penis lobes; and possessed reduced appendix masculina ranging from approximately 33 to 50% of the length found in the male. Five females lacking oostegites were 12.7 to 15.7 mm long, mean 14.6 mm; 6.8 to 8.1 mm in width, mean 7.6 mm; lacked penis lobes; and possessed reduced appendix masculina ranging from approximately 33 to 67% the length found in the male. A transitional 10.8 mm long and 5.8 mm wide with reduced penis lobes, possessed a reduced appendix masculina approximately 63% of the length found in the male.

Males were 5.0 to 10.8 long, mean 8.1 mm; 1.5 to 4.9 mm in width, mean 3.3 mm.

Two females possessed 221 and 279 spherical to subspherical embryos 0.93 to 1.08 mm (averaging 0.98) long by 0.85 to 0.99 mm (averaging 0.93) wide. One female contained 155 oblong embryos with a cephalic end formed, but not possessing eyes, 1.34 to 1.54 mm (averaging 1.44) long by 0.72 to 0.82 mm (averaging 0.77) wide. The marsupium of one female contained 135 larvae with 6 pereopods and 13 embryos with eyes, but no appendages. Internal segmentation was apparent in the embryos, which were evidently ready to molt. Embryos were 1.10 to 1.20 mm (averaging 1.15 mm) long by 0.72 to 0.82 mm (averaging 0.77 mm) wide. Larvae were 2.11 to 2.26 mm (averaging 2.16) long by 0.77 to 0.86 mm (averaging 0.82 mm) wide.

The average femininity index of the males associated with females ( $N = 6$ ) was 38.0; males not associated with females ( $N = 2$ ) 44.9; transitionals ( $N = 1$ ) 53.7; females not associated with males ( $N = 3$ ) 51.7; females associated with males ( $N = 6$ ) 49.7.

The 12 infested harlequin bass were 5.7 to 8.1 cm in standard length and averaged 7.0 cm. Damage to the host was very slight to unnoticeable.

Approximately 10% of the dorsal surface of two gravid female *R. waldneri* were covered with growths of algae. Twelve species of algae occurred in these growths (David L. Ballantine, pers. comm.). Numerous mites (Arachnoidea: Acarina) were associated with either the algae or these two isopods.

The distribution of *R. waldneri* seemed extremely limited. Extensive observations along the 17 m depth contour approximately 800 m to the north and south of the type locality indicated general habitat and abundance of the harlequin bass which were very similar to the type-locality, but no *R. waldneri* were observed. *Renocila waldneri* were not observed at 6 other localities on the south coast of the Dominican Republic.

The specific name is in honor of Raymond E. Waldner, who first noted this isopod during a scuba dive with the authors.

*Renocila thresherorum*, sp. n.

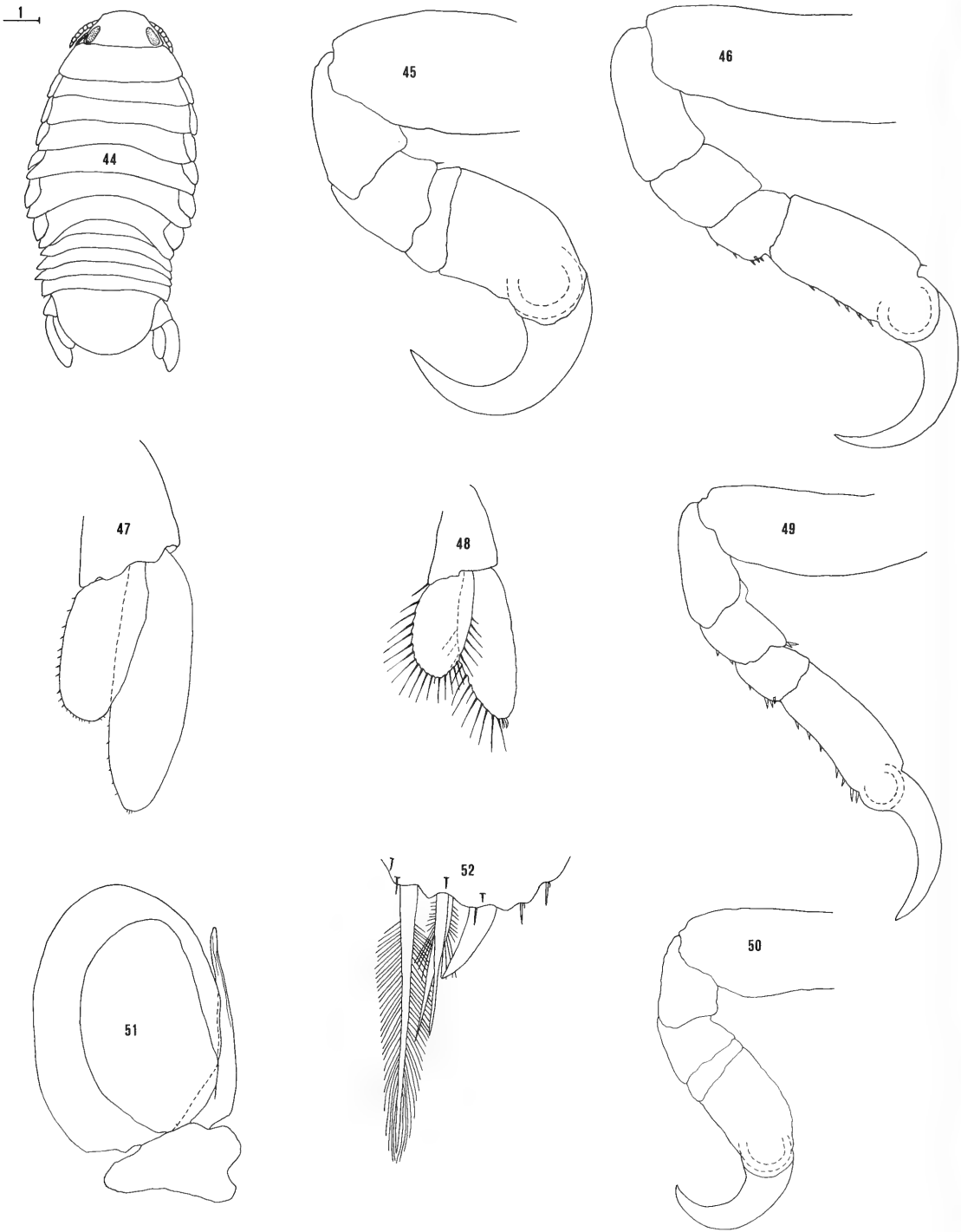
Figs. 53–79

*Type-host and locality (date and depth).*—*Apogon retrosella* (Gill), Loreto, Baja California Sur, Mexico (13 October 1978) (4.6 m).

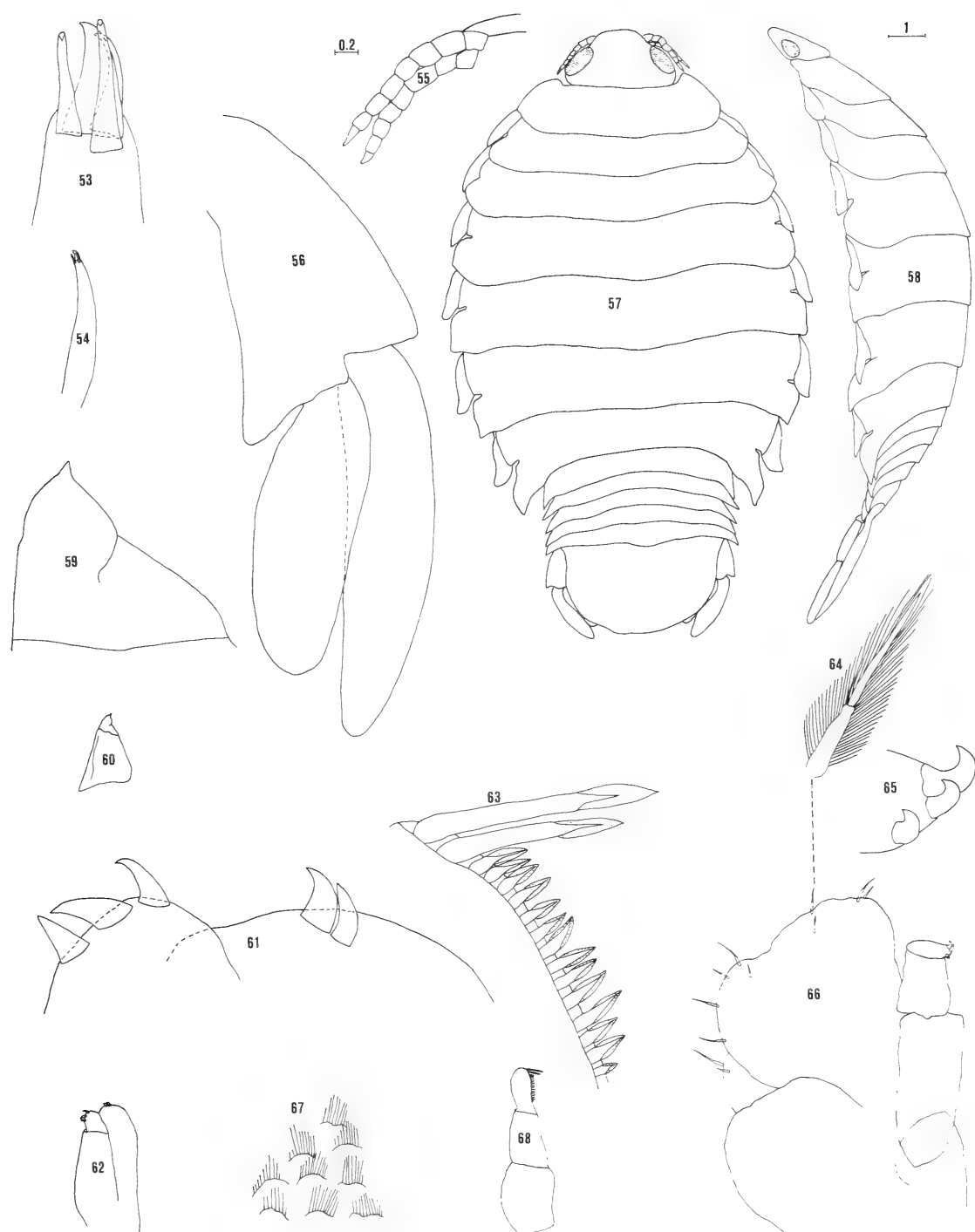
*Location.*—Male-female pair (and one singly occurring specimen; not collected), attached to dorsal surface alongside of the dorsal fin. Male and female on either side of the dorsal fin.

*Specimens studied.*—2.

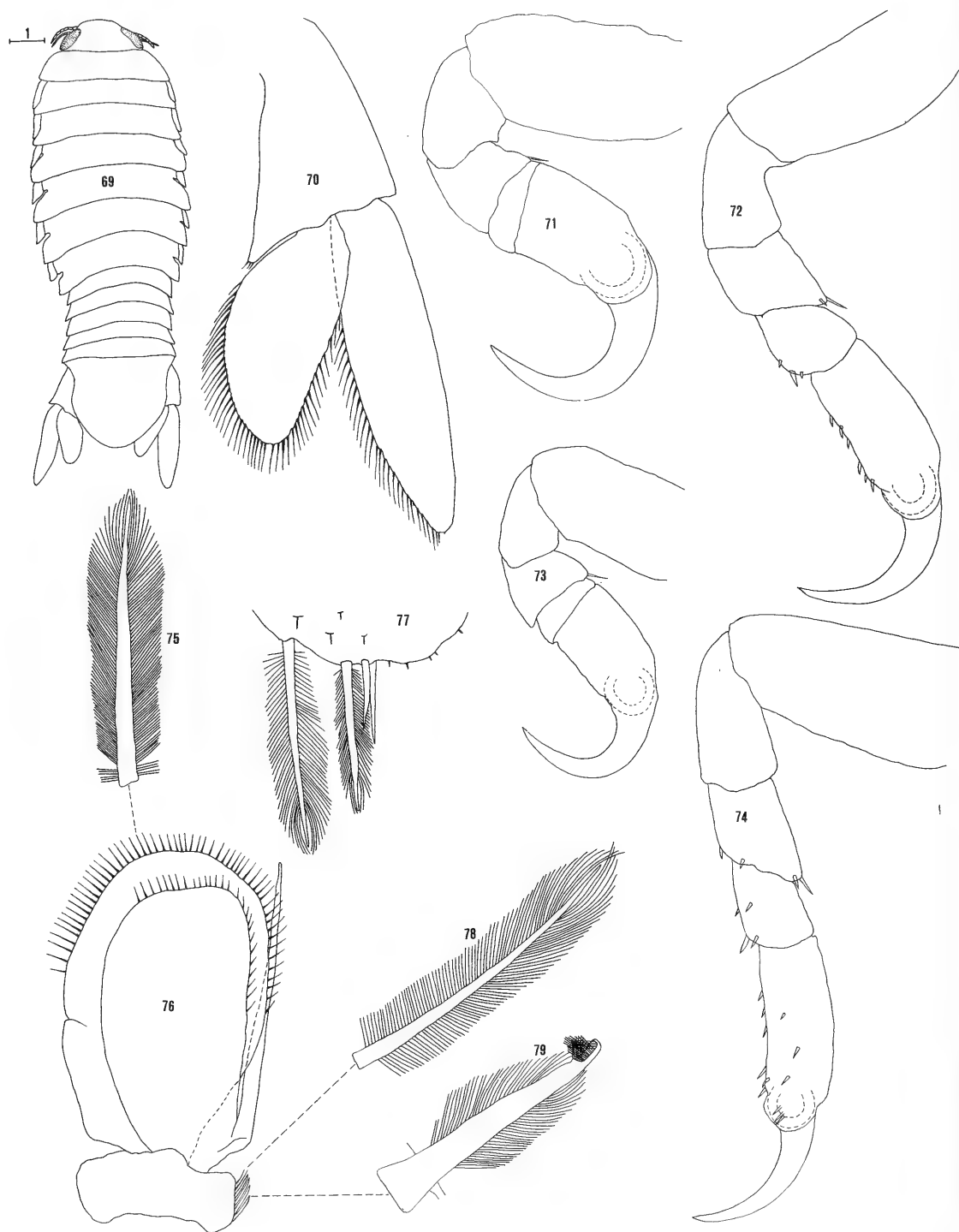




Figs. 44–52. *Renocila waldneri*: 44, Dorsal view, male allotype; 45, Pereopod 1, female holotype; 46, Pereopod 7, female holotype; 47, Right uropod, male allotype; 48, Right uropod, male paratype; 49, Pereopod 7, male allotype; 50, Pereopod 1, male allotype; 51, Pleopod 2, male allotype; 52, Distal end, outer ramus of uropod, male paratype. (Whole mouthparts and pereopods 28×; enlargements of portions of mouthparts 280×.) (Scale in mm.)



Figs. 53–68. *Renocila thresherorum*, female holotype: **53**, Apex of maxilla 1; **54**, Maxilla 1; **55**, Antennae and anterior margin of head, ventral; **56**, Right uropod, dorsal; **57**, Dorsal view; **58**, Lateral view; **59**, Apex of mandible; **60**, Mandible; **61**, Apex of maxilla 2; **62**, Maxilla 2; **63**, Apex of 3rd segment, left mandibular palp; **64**, Seta of maxilliped; **65**, Apex of palp, maxilliped; **66**, Maxilliped; **67**, Scales on maxilla 2; **68**, Left mandibular palp. (Whole mouthparts and pereopods 28×; enlargements of portions of mouthparts 280×.) (Scales in mm.)



Figs. 69–79. *Renocila threshorerorum*: 69, Dorsal view, male allotype; 70, Right uropod, male allotype; 71, Pereopod 1, female holotype; 72, Pereopod 7, female holotype; 73, Pereopod 1, male allotype; 74, Pereopod 7, male allotype; 75, Seta of pleopod 2, male allotype; 76, Pleopod 2, male allotype; 77, Distal end outer ramus of uropod, male allotype; 78–79, Setae of pleopod 2, male allotype. (Whole mouthparts and pereopods 28×, enlargements of portions of mouthparts 280×.) (Scale in mm.)

*Type-specimens*.—Holotype (female) USNM 173933; allotype (associated male) USNM 173934.

*Diagnosis*.—Anterior margin of head inflexed, not produced into lobe between bases of antennae 1. Posteroventral angle of pereonite 5 not produced, of pereonite 6 moderately produced, and of pereonite 7 produced, that of pereonite 7 overlapping pleonite 1. Lateral margins of pereonites 2–3 somewhat notched, of 4–7 notched. Telson  $\frac{1}{4}$  wider than long. Antennae 1 much broader and slightly shorter to equal in length with antennae 2. Pereopods 1–3 without swelling in dactyl and without lobe at posterodistal corner of basis. Pereopods 6–7 subequal in length. Outer ramus longer than inner ramus of uropod.

*Further details*.—Antennae 1 8-merous. Antennae 2 8-merous. First segment of mandibular palp slightly expanded; 3rd segment with 14 stout setae with broad distal ends along outer margin and 2 similar, but longer apical setae. Incisor process of mandible broad pointed with a fine tip. Maxilla 1 with 4 recurved apical spines. Distal lobes of maxilla 2 with 2 and 3 blunt spines. Distal segment of maxillipedal palp with 3 stout recurved spines.

Penis lobes of allotype male fused medially, forming a short bilobate process. Appendix masculina of male pleopod 2 linear, with unmodified apex, arising near base of endopod, about as long as endopod. The female (holotype) possessed a greatly reduced appendix masculina.

*Color*.—Dorsal of living specimens dark brown, more intensely marked on margins of pereonites and pleonites. Telson light brown centrally and on distal end. Appendages light brown.

*Remarks*.—The female was 16.7 mm in length and 9.5 mm in width, the associated male was 12.0 mm in length and 4.3 mm in width, and the host was 5.2 cm in standard length.

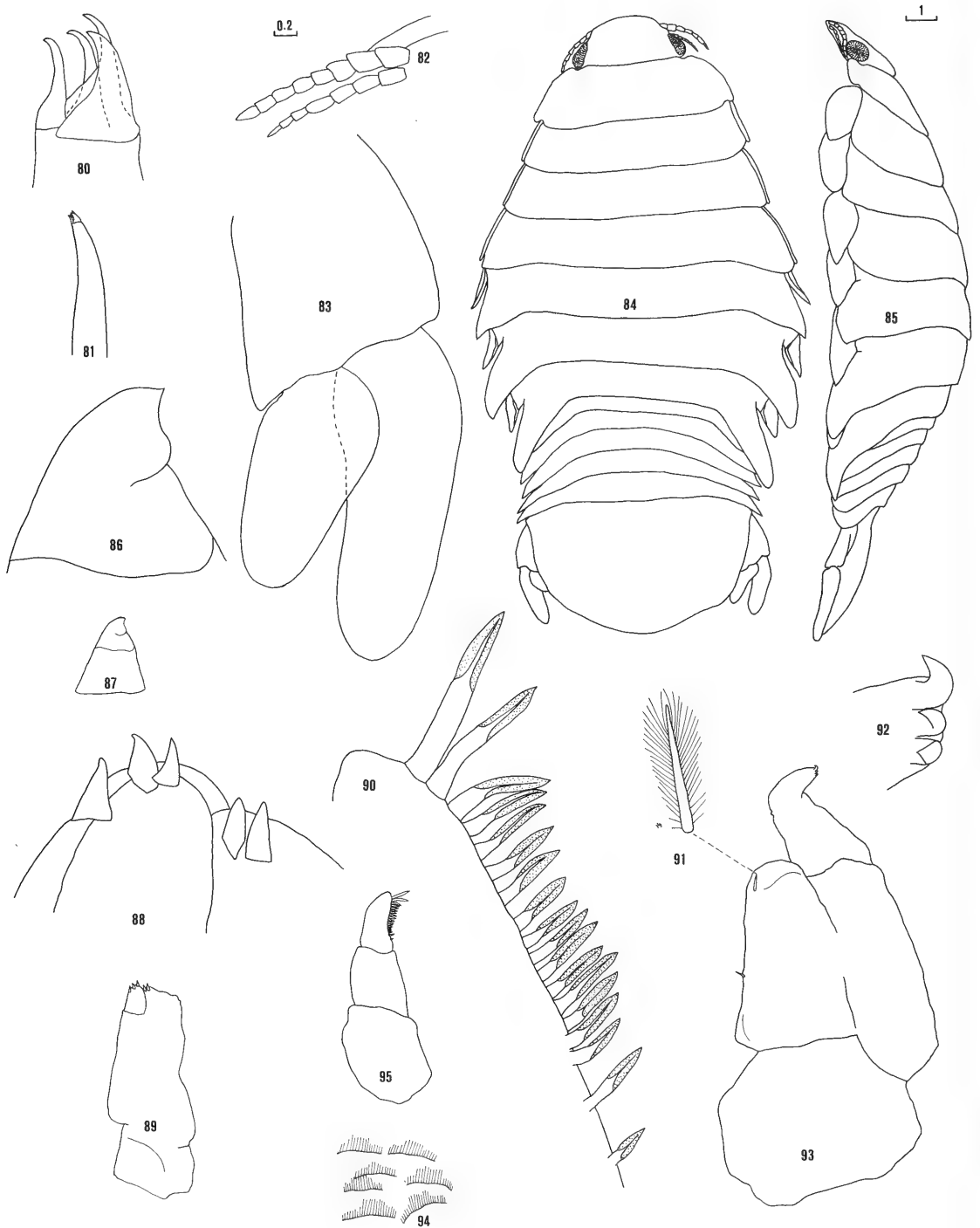
The marsupium of the female contained 147 larvae with 6 pereopods and 33 embryos with eyes, but no appendages. Internal appendages and segmentation were apparent on specimens of the later group of young when cleared in glycerine jelly. Apparently the group of young were in the process of molting when preserved. Embryos were 1.47 to 1.81 mm long and averaged 1.70 mm, and 0.78 to 0.88 mm wide and averaged 0.85 mm. Larvae were 2.55 to 2.84 mm long and averaged 2.67 mm, and 0.83 to 0.98 mm wide and averaged 0.88 mm. The female possessed a rudimentary appendix masculina.

The specific name is in honor of the discoverers and collectors of this isopod Dr. Ronald E. and Ann G. Thresher.

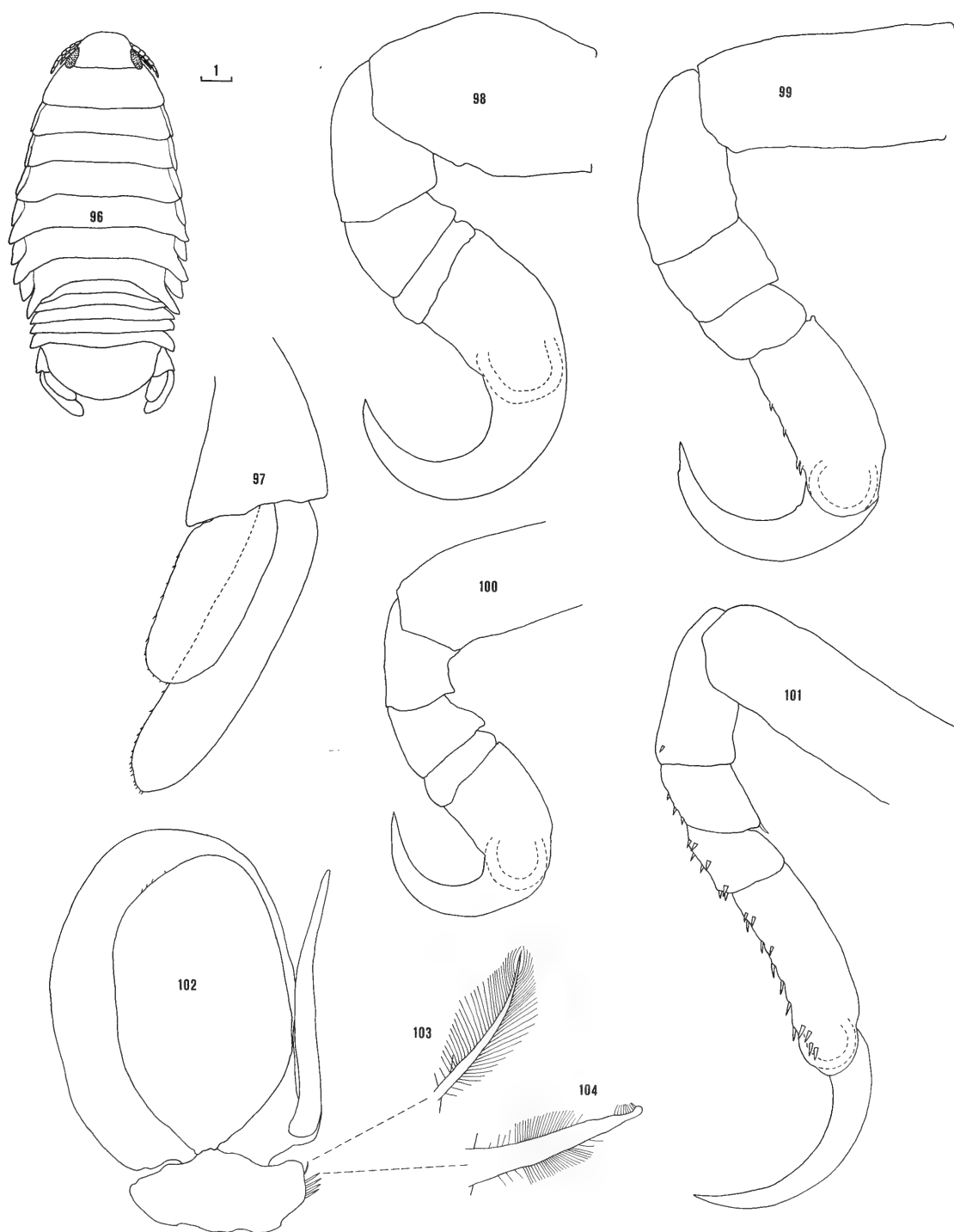
*Renocila bowmani*, sp. n.

Figs. 80–104 and 107

*Type-host locality (date and depth)*.—Harlequin bass, *Serranus tigrinus*



Figs. 80-95. *Renocila bowmani*, female holotype: **80**, Apex of maxilla 1; **81**, maxilla 1; **82**, Antennae and anterior margin of head, ventral; **83**, Right uropod, dorsal; **84**, Dorsal view; **85**, Lateral view; **86**, Apex of mandible; **87**, Mandible; **88**, Apex of maxilla 2; **89**, Maxilla 2; **90**, Apex of 3rd segment, left mandibular palp; **91**, Seta of maxilliped; **92**, Apex of palp; maxilliped; **93**, Maxilliped; **94**, Scales on maxilla 2; **95**, Left mandibular palp. (Whole mouthparts and pereopods 28 $\times$ ; enlargements or portions of mouthparts 280 $\times$ .) (Scales in mm.)



Figs. 96–104. *Renocila bowmani*: **96**, Dorsal view, male allotype; **97**, Right uropod, male allotype; **98**, Pereopod 1, female holotype; **99**, Pereopod 7, female holotype; **100**, Pereopod 1, male allotype; **101**, Pereopod 7, male allotype; **102**, Pleopod 2, male allotype; **103–104**, Setae of pleopod 2, male allotype. (Whole mouthparts and pereopods 28 $\times$ ; enlargements of portions of mouthparts 280 $\times$ .) (Scale in mm.)

(Bloch), south central coast of Saona Island, Dominican Republic (18 May 1979) (10.5 m).

*Location*.—Male-female pair attached to dorsal surface alongside of the dorsal fin. Male in contact with female along lower anterior side (Fig. 107).

*Specimens studied*.—2.

*Type-specimens*.—Holotype (female) USNM 173935; allotype (associated male) USNM 173936.

*Diagnosis*.—Anterior margin of head inflexed, not produced into a lobe between bases of antennae 1. Posteroventral angle of pereonites 5–7 produced, that of pereonite 7 overlapping pleonites 1–3. Telson  $\frac{3}{4}$  wider than long. Antennae 1 much broader and slightly longer than antennae 2. Pereopods 1–3 without swelling in dactyl and without lobe at posterodistal corner of basis. Pereopods 6–7 subequal in length. Outer ramus of uropod longer than inner ramus.

*Further details*.—Antennae 1 8-merous. Antennae 2 7-merous. First segment of mandibular palp expanded; 3rd segment with 16 stout setae with broad distal ends along outer margin, and 2 similar, but longer apical setae. Incisor process of mandible broad pointed with a fine tip. Maxilla 1 with 4 recurved apical spines. Dorsal lobes of maxilla 2 each with 2 blunt spines. Distal segment of maxillipedal palp with 3 stout recurved spines.

Penis lobes of male separate. Appendix masculina of male pleopod 2 linear, with unmodified apex, arising near base of endopod, about as long as endopod. Female (holotype) possessed a reduced appendix masculina approximately  $\frac{1}{4}$  the size occurring in the male.

*Color*.—Dorsal of living specimens and appendages uniformly black.

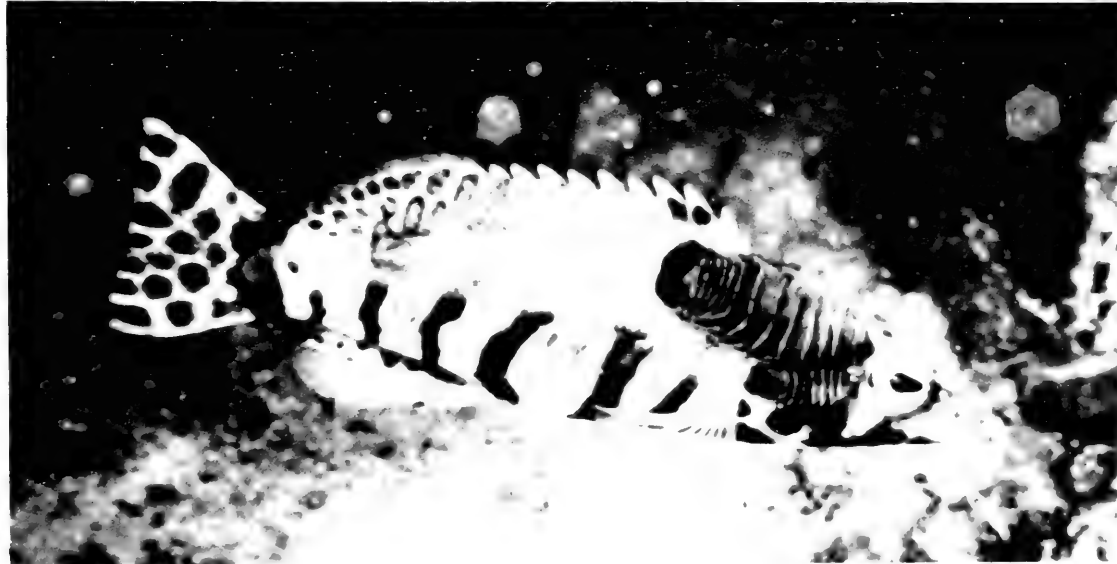
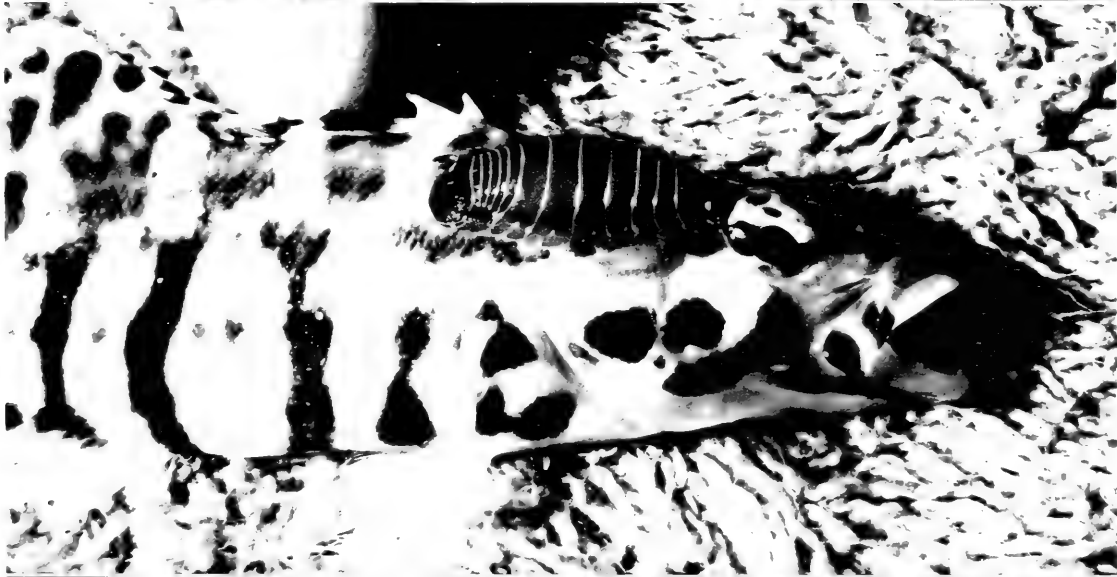
*Remarks*.—The female was 18.0 mm in length and 9.2 mm in width; the associated male was 11.5 mm in length and 4.8 mm in width; and the host was 7.8 cm in standard length. The female did not possess a marsupium.

Eight of 48 harlequin bass observed on a uniform rock bottom 10.0 to 10.5 m deep with dense growths of soft corals and scattered small coral heads were infested with *R. bowmani*. All infestations consisted of male-female pairs. Density of harlequin bass was low averaging 5 to 7 along 100 m by 5 m transects. The fish seemed to be somewhat clustered in some areas and absent in others. Infested hosts were normally isolated with only 2 parasitized fishes occupying adjacent territories.

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Fig. 105 (top): Male and female *Renocila colini* on the flamefish, *Apogon maculatus* (Poey), underwater photograph; Fig. 106 (middle): Male and female *Renocila waldneri*, sp. n., on the harlequin bass, *Serranus tigrinus* (Bloch), photograph in ship laboratory; Fig. 107 (bottom): Male and female *Renocila bowmani*, sp. n., on the harlequin bass, *Serranus tigrinus* (Bloch), underwater photograph.





The specific name is in honor of Dr. Thomas E. Bowman and his work with cymothoid isopods of fishes.

### Discussion

Bowman and Mariscal (1968) found *Renocila heterozota* only in Port Victoria, Seychelles, although Mariscal had examined numerous other populations of *Amphiprion* spp. in the Pacific and Indian Oceans. In the present study *R. colini* was only observed at Mona Island and *R. waldneri* and *R. bowmani* were only observed at the separate locations off the south coast of the Dominican Republic, although extensive collections and examinations were conducted throughout Puerto Rico, Desecheo Island, Caja de Muertos, Culebra Island, Vieques Island; St. Thomas; St. John; St. Croix; Virgin Gorda; Anagada; Chub Cay, Eleuthera, Cat Island, Conception Isle, Rum Cay, Crooked Island, Long Island, Great Exuma, Great Inagua, Little Inagua, Acklins Island, and Long Island, Bahamas; and Santa Marta and Cartagena, Colombia. *Renocila heterozota* occurred on 5 to 10% of the single species of host infested (Bowman and Mariscal, 1968); *R. colini* occurred on 25 to 33% of 2 host species; *R. waldneri* on 40 to 50% of one host species and *R. bowmani* on 16.7% of one host species. On the 4 species *Renocila* for which any biological data is available, a pattern of extremely limited geographic range, high levels of infestation, and strong host specificity is indicated. More data is needed for the remaining species to determine the extent of this pattern in other members of the genus.

Another genus of external parasitic isopods in the West Indies, *Anilocra*, contrasts markedly with the 3 species of *Renocila* described from this area. The 8 species of *Anilocra* possess wide geographic ranges, low levels of infestation, and usually specificity to several species in 1 or more genera or families of hosts. They also differ by being generally much larger and by infesting much larger hosts (Williams and Williams, unpubl. data). The known populations of *Renocila bowmani* and *R. waldneri* are separated by less than 100 km; and *R. bowmani* and *R. colini* by less than 50 km. Possibly other isolated species of *Renocila* will be discovered when the remainder of the West Indies is thoroughly examined for external isopods of fishes.

Females of *Renocila colini*, *R. waldneri*, *R. thresherorum* and *R. bowmani* possess a reduced appendix masculina. Retention of this structure has not been noted in members of the genus *Renocila*, but has been discussed by Trilles (1964).

Menzies, Bowman, and Alverson (1955) suggested that oostegites were produced during a single molt in *Lironeca convexa* Richardson, 1905, because they failed to find incompletely developed oostegites. In *Renocila colini* one female specimen possessed fully formed oostegites on pereonites

5 through 7 which had molted, but not on pereonites 1 through 4 which had not molted. Apparently the oostegites of *Renocila colini* are formed during a single molt, and possibly this may be the case for other, if not all, members of the genus.

Juveniles of *Renocila colini* and *R. waldneri* have not been collected from or observed on their host species. These isopods may not settle on their final host until they developed into males. Also lack of bone deformation suggests that these isopods do not become associated with juveniles of their final host as juvenile isopods. Possibly intermediate hosts are involved, because a prolonged planktonic existence is not compatible with the very restricted distributions of these isopods.

### Key to the Species of *Renocila*

The key is modified from a previous key by Bowman and Mariscal (1968) prepared when only 5 species were known in the genus.

- 1a. Dactyls of pereopods 1–3 with swelling on outer margin ..... 2
- 1b. Dactyls of pereopods 1–3 without swelling ..... 4
- 2a. Antennae 1 shorter than antennae 2 ..... *dubia*
- 2b. Antennae 1 longer than antennae 2 ..... 3
- 3a. Telson wider than long ..... *indica*
- 3b. Telson longer than wide ..... *periophthalma*
- 4a. Posteroventral angle of pereonite 7 reaching pleonite 1 ..... 5
- 4b. Posteroventral angle of pereonite 7 reaching pleonite 2 or beyond 6
- 5a. Posteroventral angle of pereonites 5 produced, coxae of pereonites 6–7 broad-pointed ..... *colini*
- 5b. Posteroventral angle of pereonite 5 not produced, coxae of pereonites 6–7 narrow-pointed ..... *thresherorum*
- 6a. Posteroventral angle of pereonite 7 reaching base of telson .... *ovata*
- 6b. Posteroventral angle of pereonite 7 reaching pleonite 2 or 3 ..... 7
- 7a. Outer ramus of uropod more than twice as long as inner ramus ..  
..... *heterozota*
- 7b. Outer ramus of uropod only slightly longer than inner ramus ..... 8
- 8a. Brown in color, antennae 2 8-merous, antennae 1 slightly shorter than antennae 2 ..... *waldneri*
- 8b. Black in color, antennae 2 7-merous, antennae 1 slightly longer than antennae 2 ..... *bowmani*

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G. Thresher for help in collecting isopods; and to Charles Arneson for one of the underwater photographs. Appreciation is expressed to Dr. Thomas E. Bowman, U.S. National Museum of Natural History for reviewing the manuscript. This project was supported in part by a grant from Dr. Ismael Almodóvar, President of the University of Puerto Rico.

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## A NEW *STROBILOPS* (MOLLUSCA: PULMONATA: STROBILOPSIDAE) FROM BAJA CALIFORNIA SUR, MEXICO

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*Abstract.*—*Strobilops californica*, a new species of pulmonate land snail inhabiting the Sierra de la Victoria of Baja California Sur, Mexico, is described.

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In December 1973, while searching in the high mountains of the Cape Region of Baja California, Mexico, for live specimens of *Rabdotus beldingi* (Cooper, 1892), we discovered a single dead shell of an unfamiliar species of small snail. We were successful in collecting living *R. beldingi* and other terrestrial mollusks but were unable to find additional specimens of the unknown small species. Subsequent examination by Alan Solem, Field Museum of Natural History, revealed that this unique shell is that of a species of *Strobilops*, a genus only sparsely distributed in western North America and not previously known to inhabit Baja California. Comparison with other west Mexican *Strobilops* demonstrated the Baja California form to be an undescribed species.

We collected this snail in the higher elevations of the Sierra de la Victoria, a region only rarely visited by malacologists; it is therefore unlikely that additional material of this new species will soon become available for study. While we are reluctant to describe a new species on the basis of a single specimen, we believe that the relative inaccessibility of the habitat of this species and the desirability of documenting its occurrence in Baja California justify such action at this time.

*Strobilops californica*, new species

Fig. 1

*Description.*—Shell large for genus, solid, trochiform, sharply carinate, much wider than high, finely and closely ribbed above periphery, with about 140 riblets on body whorl and 120 on penultimate whorl, convex and finely ribstriate below. It is widely umbilicate, the umbilicus contained about 3 times in diameter. Parietal callus thick, prominent where the strong parietal lamella joins it. No infraparietal or interparietal lamellae visible from the aperture, and none can be seen by transmitted light. Nearly a half whorl behind the aperture, a series of 4 basal folds can be detected by transmitted light. The innermost 3 are relatively short, subequal, parallel and equally

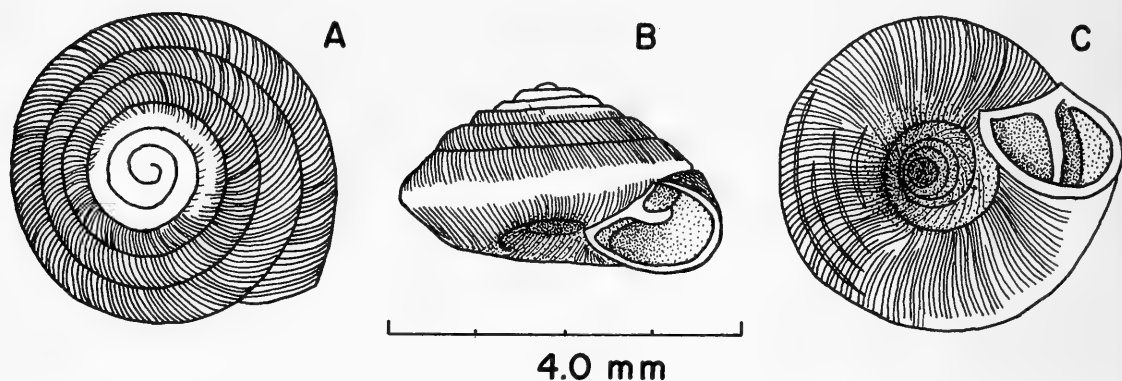


Fig. 1. Holotype of *Strobilops californica*, USNM 799595: A, Dorsal view; B, Side view; C, Umbilical view, with basal folds seen in transparency.

spaced, running for about one sixth of a whorl; the outer fold is longer, running for about one fourth of a whorl. Whorls  $6\frac{1}{8}$ , gradually increasing in size, first 2 worn and smooth, last descending abruptly to aperture. Aperture is rounded-lunate, peristome thick, only very slightly expanded.

*Holotype*.—USNM No. 799595; diameter 3.95 mm, height 1.85 mm, width of umbilicus 1.3 mm.

*Type-locality*.—La Laguna, Sierra de la Victoria, Baja California Sur, Mexico; along slope above creek immediately behind La Laguna shelter. Elevation ca. 6,500 ft., 31 December 1973, W. B. Miller and C. C. Christensen, collectors.

### Taxonomy

The subgeneric classification of *Strobilops* was summarized by Pilsbry (1927–1935, and 1948). He recognized three subgenera, namely *Strobilops* Pilsbry, 1893, *Discostrobilops* Pilsbry, 1927, and *Enteroplax* Gude, 1899.

Zilch (1959) raised *Enteroplax* to generic rank, and Solem (1968) reviewed this genus in detail. Among the characteristics of *Enteroplax* delineated by Solem are the low conic shell, prominent radial ribs above threaded periphery and in umbilicus, sculpture absent on body whorl below periphery, strongly elevated edge of parietal callus which fuses with the upper parietal lamella, and the presence of 2 parietal lamellae. *Enteroplax* is currently known only from the Philippine Islands and New Guinea.

In the genus *Strobilops*, the subgenus *Discostrobilops* is strongly depressed, subdiscoidal, and widely umbilicate, while *Strobilops* s.s. has trochiform shells with a narrow to moderate umbilicus.

Although *S. californica* has many characters of *Enteroplax*, namely the low conic shell, the strongly elevated edge of the parietal callus, and a wide umbilicus, it does not have a threaded periphery and it does have a sculpture of fine radial striae on the body whorl below the periphery. Because of these

distinctions, we consider *S. californica* to belong properly in the genus *Strobilops*. However, it does not appear to fit perfectly in either of the described subgenera of *Strobilops*. Since we do not feel justified in describing a new subgenus on the basis of a single shell without anatomical data, we believe that subgeneric classification should be deferred until additional specimens, including anatomies, can be obtained.

### Differential Diagnosis

Other species of *Strobilops* inhabiting western Mexico are found on Socorro Island about 400 km southwest of the southern tip of Baja California, and, presumably, in Sinaloa.

The species presumed from Sinaloa, *Strobilops sinaloa* Morrison, 1953, was described from material found by U.S. Department of Agriculture inspectors on a shipment of plants said to have originated in Sinaloa, Mexico. It is a *Discostrobilops* and has the depressed shell of that subgenus.

Specimens of *Strobilops* from Socorro, one of the Revillagigedo Islands, have been cited in print under three names. Dall (1926) identified specimens from a single locality (CAS Loc. 24,782) as *S. labyrinthica* (Say) and *S. strebeli* (Pfeiffer). Pilsbry (1927–1935) described material from the same Socorro locality as *S. hannai*, stating that this was the species identified by Dall as *S. labyrinthica* and that Dall's *S. strebeli* was probably also this species. We have examined the holotype of *S. hannai* in the collection of the Academy of Natural Sciences of Philadelphia (ANSP 256587a) and the Socorro Island specimens in the California Academy of Sciences collection identified by Dall as *S. labyrinthica* and *S. strebeli*. We found that the two specimens identified as *S. labyrinthica* were unquestionably that species; the two specimens identified as *S. strebeli*, however, were more widely umbilicate and more depressed than typical *S. strebeli* and are probably *S. hannai*, as Pilsbry suggested. Unfortunately, we did not have the holotype of *S. hannai* at the same time that we were examining Dall's specimens so that a direct comparison could not be made. Nevertheless, it was immediately obvious that Dall's "*S. strebeli*" from the CAS and Pilsbry's *S. hannai* from the ANSP were both only about two-thirds the diameter of *S. californica*; they were also more coarsely ribbed and narrowly umbilicate.

### Discussion

At the type-locality the vegetation consisted primarily of oaks (*Quercus devia* and *Q. tuberculata*) and piñon pines (*Pinus cembroides*). We found many live specimens of *R. beldingi* as well as many shells of *R. levis* (Dall, 1893), *R. montezuma* (Dall, 1893), *Pseudosubulina eiseniana* (Cooper, 1893), *Glyphyalinia* cf. *paucilirata* (Morelet, 1851), and live animals of *Deroceras* cf. *laeve* (Müller, 1774). This faunal association of the high oak-pine

forest was understandably different from the lower desert communities of Baja California (Christensen, 1979).

The significance of finding *S. californica* in that locality, however, was not apparent to us at the time as we did not recognize it in the field as a *Strobilops* and because we were intent on finding *R. beldingi*. Our failure to find additional specimens of *S. californica* was due to our concentration of collecting effort in the vicinity of rock outcrops (typical *Rabdotus* habitat) rather than under fallen logs and leaf mold, where *Strobilops* would be more likely to occur.

The single specimen of *S. californica* is an adult shell, solid, and recent, as indicated by fresh periostracum in the umbilicus and on the base of the body whorl.

### Acknowledgments

We are grateful to Barry Roth for the loan of the California Academy of Sciences specimens, to Joseph Rosewater for facilitating our examination of specimens at the United States National Museum, and to George Davis, Robert Robertson, and the staff of the Academy of Natural Sciences of Philadelphia for facilitating our examination of the ANSP collection. The visit to Philadelphia by one of us (CCC) was supported by the Jessup Fund of the ANSP.

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## A GIANT EXTINCT INSECTIVORE FROM CUBA (MAMMALIA:INSECTIVORA:SOLENODONTIDAE)

Gary S. Morgan, Clayton E. Ray, and Oscar Arredondo

*Abstract.*—A femur, identified as that of a previously unknown giant solenodontid insectivore, is reported from a fossil deposit in Cuba containing a typical Greater Antillean late Pleistocene mammalian fauna. The fossil is closest in morphology to *Solenodon cubanus* among known insectivores. Lack of adequate material precludes description of a new taxon, although the femur probably represents an undescribed species of *Solenodon*. Based on measurements of the femur, the giant Cuban solenodontid would have been considerably larger than any living member of the Insectivora. Addition of a new very large insectivore suggests a substantial radiation of insectivores in the Greater Antilles, similar to that of capromyid rodents and of megalonychid sloths.

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This report is based on a partial femur (USNM 299480) from western Cuba belonging to a previously unknown mammal. The specimen was collected on 15 March 1959 by Oscar Arredondo and César García del Pino from the Abra de Andrés, Las Alturas de Esperón, Mesa de Anafe, Sierra del Rosario, near the city of Guanajay, Pinar del Río Province, Cuba. According to the new geographic subdivision of Cuba, this locality is now in Habana Province, but because maps showing the new Cuban provinces are not generally available at present, we will use the more conventional boundaries and names of the Cuban provinces. The femur was collected from a reddish-colored breccia deposited in a crevice in a rock wall of Miocene age. A late Pleistocene age is suggested for the breccia based on the vertebrate fossils collected from it. The associated vertebrate fauna includes three species of small megalonychid ground sloth, *Megalocnus rodens*, *Mesocnus* sp. and *Neocnus gliriformis* (for use of *Neocnus* rather than its synonyms *Microcnus* and *Cubanocnus* see Varona, 1976), and two species of capromyid rodent, *Geocapromys columbianus* and *Capromys* sp. (either *C. pilorides* or *C. prehensilis*). All of these species have been recovered from late Pleistocene cave deposits elsewhere in Cuba and, with the exception of *Capromys*, all are now extinct. Although much paleontological field work has been conducted throughout Cuba during the past 20 years, no additional specimens referable to this unique mammal have yet come to light.

*Description of femur.*—The fossil femur which is the subject of this study lacks the head, much of the lesser trochanter, and the medial condyle (Fig.



1). It is relatively short and massive with a prominent greater trochanter, third trochanter, trochanteric fossa, and intertrochanteric crest. The femoral shaft is straight for most of its length, but is flexed slightly anteriorly near the proximal end. The shaft is nearly hemicircular in cross section, convex on the anterior surface and almost flattened on the posterior surface. The greater trochanter appears to have projected approximately 4–5 mm above the femoral head and is separated from the head by a deep groove on the anterior surface. In anterior aspect, the greater trochanter is broad at its base narrowing proximally to a relatively sharp prominence. On the anterior surface of the greater trochanter just distal to the proximal end there is a small, transversely elongate protuberance, presumably for attachment of the gluteus minimus. In lateral view, the greater trochanter is flexed somewhat anteriorly and is broadly rounded proximally. The trochanteric fossa is well developed, forming a very deep pit in the posterior surface of the greater trochanter. The intertrochanteric crest is prominent and composed of two portions; the anterior part is a thin ridge of bone arising at the tip of the greater trochanter and forming the posterior border of the trochanteric fossa and the distal portion of the crest is transverse to the shaft and is gently concave. The vertical and horizontal portions of the intertrochanteric crest meet at nearly a right angle ( $85^\circ$ ) just proximal to the third trochanter. Although broken off near its base, the lesser trochanter appears to have been strongly developed and to have met the medial edge of the shaft at approximately a right angle. The lesser trochanter is located slightly higher on the shaft than is the third trochanter. The third trochanter is a very prominent triangular-shaped process which extends about one-sixth the length of the femur. On the distal end, the patellar groove, although partially missing, is relatively narrow, slightly concave, and projects anteriad of the femoral shaft. Proximal to the patellar trochlea there is a deep pit for reception of the patella during strong extension of the leg. The distal end of the femur is deep anteroposteriorly, but is not particularly broad. The articular surface of the lateral condyle is vertical and relatively narrow, whereas the intercondylar notch is comparatively broad.

*Comparison with other mammals.*—Although incomplete, this specimen retains enough diagnostic features to permit detailed comparisons with other mammalian groups. We have compared the fossil femur with femora of representative genera of all orders of native mammals known from the late

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Fig. 1. A, C, E, G.—Posterior, anterior, lateral, and medial views of giant solenodontid femur from the Abra de Andrés, near Guanajay, Pinar del Río Province, Cuba (USNM 299480); B, D, F, H.—Posterior, anterior, lateral, and medial views of the left femur of *Solenodon cubanus* (USNM 49508). All views  $\times 7/6$ .



Pleistocene and modern fauna of the West Indies. Only the Marsupialia, Insectivora, Chiroptera, and Rodentia are represented in the contemporary fauna of the West Indies. Primates and Edentata are added when late Pleistocene faunas are included. Specimens from the following collections were used in this study: National Museum of Natural History (USNM), Carnegie Museum of Natural History (CM), Florida State Museum (UF), and the personal collection of Oscar Arredondo (OA).

The femora of Chiroptera can be excluded from further consideration for obvious reasons such as their small size, very slender shaft, and highly derived morphology of the proximal end. The only marsupials in the West Indies are the didelphid genera *Didelphis* and *Marmosa*, both known in this region only from the Lesser Antilles. The femur of these marsupials is quite different from that of the fossil. The femoral shaft is much longer and more slender, the third trochanter is virtually absent, the greater trochanter extends only slightly proximal to the head, and the patellar trochlea is very broad, as is the articular facet of the lateral condyle. Many features of the femora of New World monkeys, the elongate shaft, reduced third trochanter located in a more proximal position, and the comparatively broad patellar trochlea, preclude placement of the fossil in the Primates. In the rodent femora examined, the lesser trochanter is located primarily on the posterior surface of the femoral shaft, the third trochanter is vestigial and located far distal to its position in the fossil, and the patellar groove is much deeper. Small, extinct ground sloths of the family Megalonychidae are the only representatives of the Edentata in the West Indies. The femur in these small sloths differs strikingly from that of the fossil in such features as the relative proportions of the shaft, the weak development of the greater and lesser trochanters, trochanteric fossa, and intertrochanteric crest, and the shape of the patellar groove. Only in the femora of certain genera in the order Insectivora can a reasonably close match be found for the Cuban fossil femur.

Femora of all living insectivore families were available for study, with the number of genera examined for each family following it in parentheses: Solenodontidae (1), Tenrecidae (7), Chrysochloridae (4), Soricidae (11), Talpidae (7), and Erinaceidae (7). Following Butler (1972) and McKenna (1975) the tree shrews (Tupauidae) and elephant shrews (Macroscelididae) are excluded from the Insectivora (*sensu stricto*, i.e. restricted to the Lipotyphla), but in any case the fossil bears little resemblance to the femora of either group. In addition to living insectivores, the fossil was compared to the femur of *Nesophontes*, the only genus in the extinct Greater Antillean insectivore family Nesophontidae and to the femora of several fossil *Solenodon*-like forms and the extinct solenodontid *Antilloegale* (regarded as *Solenodon* by Van Valen, 1967, and Varona, 1974). The fossil Cuban insectivore was also compared to the femur of *Deinogalerix koenigswaldi*

from the Miocene of Italy, the largest known insectivore, living or extinct (Freudenthal, 1972).

With the exception of one genus of tenrec, the fossil differs considerably from the femora of all tenrecids and chrysochlorids, all of which have the greater trochanter approximately even with or lower than the head, lack a well defined trochanteric fossa and intertrochanteric crest, and have a smaller third trochanter located farther distally on the shaft. The femur of *Microgale*, one of the smallest genera of tenrecs, is similar to the fossil in morphology, differing only in its considerably smaller size and elongate, flange-shaped third trochanter. The fossil bears little resemblance to the femur of any living talpid or soricid. Besides the obvious discrepancy in size, the femur in moles and shrews lacks a well developed trochanteric fossa and intertrochanteric crest, has the third trochanter located higher on the shaft, and is relatively broader distally. Modern erinaceids are divisible into two subfamilies, the Erinaceinae and Echinosoricinae, which differ significantly in their femoral morphology. Erinaceine femora differ in a number of ways from the Cuban fossil, including having a less pronounced greater trochanter, the trochanteric fossa not as concave, and the third trochanter developed as an elongate flange extending nearly one-third the length of the shaft. The patellar groove in hedgehogs does not extend nearly as far proximally as it does in the fossil and the lateral condyle is somewhat reduced. Among living echinosoricines, the fossil femur resembles most closely the femur of *Echinosorex*, especially in its overall proportions and in the strong development of the greater trochanter, third trochanter, and trochanteric fossa. However, the morphology of the distal end of the femur in *Echinosorex* is like that of other erinaceids and quite unlike the Cuban fossil. The femur of the gigantic extinct echinosoricine *Deinogalerix* is very similar in most respects to the femur of *Echinosorex*, except, of course, for its tremendous size. As with *Echinosorex*, several fundamental differences in the distal end of the femur argue against a close relationship between *Deinogalerix* and the Cuban specimen. Nonetheless the femora of these two giant insectivores are quite similar in gross morphology, particularly in their long, relatively gracile (for an insectivore) overall form and the strongly developed greater trochanter, third trochanter, and trochanteric fossa.

As was suspected on the basis of geography, the fossil bears a closer resemblance to the femora of the West Indian insectivores *Solenodon* and *Nesophontes* than it does to those of any other living insectivores. Although there are some minor differences, the femora of these two genera are more similar to one another than either is to that of any other living insectivore. The differences in postcranial osteology between these two genera are less pronounced, for instance, than the differences observed between certain genera within the Tenrecidae or Erinaceidae. McDowell (1958) summarized the many similarities in the cranial and postcranial osteology of *Solenodon*

and *Nesophontes* and hypothesized a close phylogenetic relationship between them, placing both genera in the Solenodontidae. However, the profound differences in dentition between *Solenodon* and *Nesophontes* seem to preclude their placement in the same family, at least in the present state of our knowledge of insectivore relationships. The possibility does exist that the Solenodontidae and Nesophontidae are closely related within the soricomorph insectivores and may even have been derived from a single "invasion" of the West Indies or "proto-Antilles" by a late Cretaceous or early Tertiary soricomorph (MacFadden, in press).

*Comparison with Solenodon, Nesophontes, and Antillocale.*—To determine if the fossil femur is closest in morphology to *Solenodon*, *Antillocale*, or *Nesophontes*, the fossil was compared to the femora of all living and extinct West Indian insectivores for which the femur is known. These include, *Solenodon cubanus* and several large *Solenodon cubanus*-like forms, all from Cuba, *S. paradoxus* and *Antillocale marcanoi* from Hispaniola, and six species of *Nesophontes*, three from Hispaniola and one each from Puerto Rico, Cuba, and the Cayman Islands.

The most striking feature of the fossil femur is its large size. It is 27% longer than the longest modern *Solenodon* femur measured (Table 1) and is considerably larger than the femur of any living insectivore. Aside from the obvious difference in size, the largest *Nesophontes* being barely half the size of *Solenodon* or *Antillocale*, the femur of *Nesophontes* differs consistently from those of the latter two genera in several features. *Antillocale* and *Solenodon* are certainly closely related, if not congeneric, and in femoral morphology they are quite similar. In the following comparison of femoral characters in *Nesophontes* and *Solenodon*, the characters ascribed to *Solenodon* apply also to *Antillocale*, unless noted otherwise. In *Solenodon* the lateral condyle is transversely flattened, in contrast to its convexity in *Nesophontes*. The patellar groove of *Solenodon* projects anteriorly of the shaft, unlike *Nesophontes* in which the patellar trochlea is in line with the axis of the femoral shaft. *Solenodon* has a deep pit on the anterior surface of the shaft just proximal to the patellar groove, for reception of the patella in strong extension of the lower leg. This pit is very weakly developed in the large species of *Nesophontes*, *N. edithae*, and is absent in the smaller species. In all *Solenodon* specimens examined, the third trochanter is more strongly developed than in any species of *Nesophontes* and is located slightly higher on the shaft. The lesser trochanter is of slightly different shape in the two genera, pointed and projecting at a right angle from the shaft in *Nesophontes* and triangular, relatively broader, and projecting somewhat proximally in *Solenodon*. The femur of *Solenodon* has a longer neck and a slightly oblong head, whereas the neck is shorter in *Nesophontes* (owing at least in part to the relatively larger head) and the head is almost perfectly hemispherical. The greater trochanter in *Solenodon* exhibits a strong an-

	Total length	Shaft length	Maximum proximal width	Height of greater trochanter	Minimum shaft width	Minimum shaft thickness	Maximum shaft width at third trochanter	Maximum width of condyles	Maximum distal width	Maximum distal thickness	Width of patellar groove	Index of robustness of minimum shaft width/total length
giant fossil solenodontid (USNM 299480)	66.1	60.4	—	4.5	7.1	6.2	11.6	—	—	14.4	—	.107
<i>Solenodon cubanus</i> (USNM 49508)	47.3	43.9	13.3	2.5	4.7	3.8	7.9	11.1	11.8	10.2	6.3	.099
<i>Solenodon</i> cf. <i>cubanus</i> fossil (OA 301)	57.7	46.0	16.0	3.5	6.0	—	9.7	13.6	14.5	12.8	7.0	.104
<i>Solenodon</i> cf. <i>cubanus</i> fossil (OA 2943)	—	—	15.5	3.2	6.3	5.0	9.3	—	—	—	—	—
<i>Antillogale marcanoi</i> fossil (CM 35036)	41.2	38.3	12.7	2.1	5.4	4.7	7.6	11.1	12.4	9.6	7.5	.131
<i>Solenodon</i> cf. <i>paradoxus</i> fossil (USNM 299486)	40.0	37.1	12.3	2.2	4.6	4.3	7.6	9.9	11.0	8.2	5.6	.115
<i>Solenodon paradoxus</i> (N = 9)												
$\bar{x}$	46.3	42.9	14.1	2.5	5.3	4.3	8.3	11.6	13.0	9.9	7.0	.114
OR	42.7-48.5	39.9-45.2	13.5-14.6	2.2-3.0	4.9-5.7	3.7-4.8	7.5-9.4	10.9-12.4	12.0-13.6	8.9-10.8	6.3-7.7	
V	4.00	4.31	2.66	12.49	4.37	7.80	7.83	3.97	3.87	5.52	6.04	
<i>Nesophontes edithae</i> (N = 20)												
$\bar{x}$	23.4	21.9	6.1	1.5	2.7	2.1	3.5	5.0	5.3	4.6	3.1	.113
OR	21.1-24.8	20.0-23.1	5.6-6.5	1.2-1.8	2.2-3.0	1.7-2.3	2.9-3.9	4.7-5.4	4.9-5.7	4.1-5.2	2.8-3.5	
V	4.41	4.30	4.28	11.59	8.17	7.52	8.32	4.42	4.34	5.50	6.93	
<i>Nesophontes paramicus</i> (N = 20)												
$\bar{x}$	17.8	16.7	4.3	1.1	1.7	1.5	2.6	3.4	3.6	3.3	2.0	.096
OR	16.5-19.8	15.5-18.7	4.0-4.7	0.9-1.4	1.4-2.1	1.3-1.7	2.3-3.1	3.1-3.7	3.3-3.9	2.9-3.7	1.8-2.2	
V	4.74	4.55	4.84	11.53	9.15	8.35	7.32	4.45	4.47	6.41	7.03	

terior flexion which is not nearly as pronounced in the smaller genus. Finally, there is a difference in the angle formed by the intertrochanteric crest, acute in *Solenodon*, right to obtuse in *Nesophontes*.

Difficulties arise when the fossil is compared to all species of *Solenodon* and *Nesophontes*, rather than to generalized characters for the individual genera. Comparisons reveal that there are notable differences between the femora of the species within each of these two genera. For instance, the femur of *Nesophontes edithae* differs considerably from the femora of the smaller species of the genus, particularly in its relatively larger head, broader patellar groove, and comparatively broader shaft. The index of robustness (minimum shaft width/total length of femur) reveals that the femur of the *N. edithae* specimens measured is as robust as the femur of *Solenodon paradoxus*, an animal twice its size. The remaining species of *Nesophontes* have more slender femora.

Although only one skeleton of modern *Solenodon cubanus* was available for study, we did examine two fossil femora from western Cuba of a form very close to the modern Cuban solenodon. *Solenodon cubanus* appears to differ in several important femoral characters from *S. paradoxus*. The index of robustness demonstrates clearly that the femur of *S. cubanus* is of more slender build than that of *S. paradoxus*. Unlike *S. paradoxus* and like *Nesophontes*, the greater trochanter in *S. cubanus* is not flexed anteriorly to a marked degree. The patellar groove in *S. cubanus* is narrower and less concave than in *S. paradoxus* and the pit proximal to this groove is shallower in the former.

The femur of *Antillogale marcanoi* differs from that of *S. cubanus* and *S. paradoxus* in several features. The most striking feature of *Antillogale* is the relative massiveness of its limb elements. Like the humerus and ulna described by Patterson (1962), the femur of *Antillogale* is similar to that of *S. paradoxus* in the breadth of the proximal and distal ends, but has a noticeably shorter shaft, giving it a much stouter, more massive appearance. In addition, the femoral shaft of *Antillogale* has a distinct curvature not observed in other West Indian insectivores. The pit on the anterior surface of the shaft proximal to the patellar groove is deeper and the greater trochanter is flexed anteriorly to a greater degree than in either species of *Solenodon*. In these last two features and in the relative robustness of the shaft and broad, concave patellar trochlea, the femur of *Antillogale* more closely resembles that of *S. paradoxus* than it does the femur of *S. cubanus*, *Nesophontes*, or the Cuban fossil.

In almost every aspect of its morphology, the Cuban fossil femur resembles the femur of *Solenodon cubanus* more closely than it does the femur of any other West Indian insectivore (Fig. 1). Although the giant fossil femur does resemble *Nesophontes* more closely in several characters than it does *S. paradoxus*, particularly in the slenderness of the shaft and the reduced

anterior flexion of the greater trochanter, it also shares these characters with *S. cubanus*. In characters such as the stronger development and the more proximal location of the third trochanter, the angle formed between the shaft and the lesser trochanter, the length of the femoral neck, the angle formed by the intertrochanteric crest, the shape of the lateral condyle, the anterior projection of the patellar groove, and presence of a well defined pit proximal to the patellar groove, the fossil resembles *Solenodon* more closely than *Nesophontes* and in particular, resembles *S. cubanus* more closely than *S. paradoxus* or *Antilloegale*.

Although the fossil femur is most similar to the femur of *Solenodon cubanus* among known insectivores, several differences are apparent, the most obvious being one of size. The fossil solenodontid femur is 1.4 times longer than that of modern *S. cubanus*. The ratio of femur length/head and body length was calculated for three modern individuals of *Solenodon paradoxus*, the species most closely related to the fossil for which these data are available. The resulting ratio ( $\bar{x} = .14$ ) suggests a head and body length for the fossil solenodontid of approximately 470 mm. This is about the size of a large adult male opossum (*Didelphis virginiana*), and is considerably larger than any living member of the Insectivora. There are several fossil *Solenodon* cf. *cubanus* femora from western Cuba which are intermediate in size between modern *S. cubanus* and the giant solenodontid (Table 1). These specimens are very similar to *S. cubanus*, differing primarily in their larger size. Based on the available fossil material, it is not clear if these intermediate-sized specimens represent a third late Pleistocene solenodontid species or are representative of a late Pleistocene population of *S. cubanus* which was larger than the modern form. Other characters which distinguish the giant solenodontid from *S. cubanus* are the more prominent greater trochanter, deeper trochanteric fossa, better developed groove separating the head from the greater trochanter, larger third trochanter, and slightly concave lateral condyle. Most of these characters are not unique to the giant solenodontid, but rather are characters found developed to a lesser degree in *Solenodon cubanus*. It is possible that the observed differences are related to the large size of the fossil, but this cannot be determined from the limited material available.

In summary, the giant insectivore femur can be assigned confidently to the Solenodontidae. In morphology it agrees closely with *Solenodon*, in particular with *S. cubanus*, to which the fossil appears to be most closely related among known insectivores. This specimen almost certainly represents an undescribed species, tentatively assignable to the genus *Solenodon*, but the incomplete femur described here does not provide adequate material for the formal description of a new taxon.

*Discussion.*—The presence in the late Pleistocene fauna of Cuba of a giant solenodontid, larger than any living insectivore, raises some intriguing ques-



tions regarding its ecological position in that fauna. Based on the carnivorous habits of its closest living relatives, it seems likely that the giant Cuban solenodontid was also carnivorous, at least in part. Certainly *Solenodon paradoxus* eats small mammals, lizards, and frogs, in addition to various invertebrates (based on observations of captive *S. paradoxus* by C. E. Ray and others; see also Allen, 1910; Peña, 1977; Verrill, 1907), so it is not inconceivable that a very closely related animal of considerably larger size would have preyed on small to medium-sized vertebrates. Taken in the context of the entire Cuban fauna, the carnivorous habits of *Solenodon* and possibly the giant solenodontid may reflect the absence of other mammalian predators. In the absence of members of the Carnivora, the majority of carnivorous niches in Cuba are filled by nonmammalian predators. The largest native carnivorous vertebrates on Cuba today are the boa, *Epicrates angulifer*, several species of medium-sized raptorial birds, and *Solenodon cubanus*. The inclusion of late Pleistocene faunas would add the gigantic flightless owl, *Ornimegalonyx oteroi*, two species of giant barn owl, the extinct eagle, *Aquila borraisi*, and possibly the giant solenodontid.

Absence of members of the Carnivora from Cuba invites comparison with other well known faunas in which carnivores (i.e. Carnivora) are absent. In the near absence of Carnivora in the Tertiary of South America (with the exception of procyonids in the Neogene) an impressive array of carnivorous marsupials and large flightless predaceous birds is found (Marshall, 1977). In Australia there evolved a full complement of marsupial carnivores and the titanic varanid lizard, *Megalania*, in addition to several other medium-to large-sized carnivorous varanids (Hecht, 1975). There are, however, no members of the Insectivora in either of these faunas (with the minor exception of small shrews of the genus *Cryptotis* in the modern fauna of northernmost South America). Olson (1978) noted the striking parallel between the Miocene fauna of the Gargano Peninsula of Italy (Freudenthal, 1972) and that of the late Pleistocene of Cuba. The Gargano Peninsula was apparently an island in the Miocene and during that time its faunas are characterized by the virtual absence of carnivores (with the exception of an otter of remarkably large size) and by the presence of several species of large raptorial birds, the largest known insectivore, *Deinogalerix koenigswaldi*, and rodents of very large size (Freudenthal, 1972). The virtual absence of mammalian carnivores and the presence of a giant insectivore and very large raptorial birds mirrors the situation in Cuba during the late Pleistocene. Giant rodents are unknown from Cuba, but the small Cuban ground sloths may have occupied a similar niche. It is probably no coincidence that the giant Cuban solenodontid and *Deinogalerix*, the largest of known insectivores living or extinct, both occur in faunas devoid of other mammalian predators. Competition from more advanced predators of the Carnivora has

probably prevented modern insectivores from attaining the large size of these two fossil forms.

The giant solenodontid described here, in addition to recently discovered species of *Nesophontes* from Puerto Rico, Vieques, Cuba, and the Cayman Islands, provides evidence to support our conviction that the Quaternary vertebrate fauna of the West Indies is at present incompletely known. Furthermore, the lack of terrestrial vertebrate fossils in the West Indies older than the late Pleistocene strongly indicates that there is still much to learn about the Greater Antillean insectivore fauna. If the Greater Antillean insectivores were derived from North American early Tertiary soricomorphs as suggested by most authors (MacFadden, 1980; Matthew, 1918; Patterson, 1962; Simpson, 1956), we might justifiably expect an insectivore radiation similar to that of another soricomorph group apparently isolated on an island since the early Tertiary, the Tenrecidae of Madagascar. Rather extensive radiations of capromyid rodents, including eight endemic genera and at least 15 species, and megalonychid ground sloths, including seven endemic genera and eight species, have been documented in the Greater Antilles. Both of these radiations have probably taken place since the early Miocene. With the addition of a new species of solenodontid we now know of three genera and at least a dozen species of endemic Antillean insectivores. These figures compare with 12 genera and approximately 25 species of tenrecs on Madagascar, an island about five times larger than Cuba and of considerably greater ecological diversity than any West Indian island. The discovery of a giant solenodontid on Cuba raises the possibility that an even more extensive radiation of insectivores remains to be discovered in the West Indian fossil record.

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## ADDENDUM

Arredondo and Varona (1974. *Poeyana* 131:1–12) described a new genus and species of extinct canid, *Cubacyon transversidens*, based on a partial maxilla with two teeth from a cave deposit in Cuba. Olson (1978) questioned the validity of this species and Hall (in press. *The Mammals of North America*, 2nd Ed., The Ronald Press, New York) synonymized it with the domestic dog, *Canis familiaris*. Morgan and Ray follow Hall in regarding *Cubacyon* as a domestic dog. Arredondo and Varona (1974; in litt.), however, believe that *C. transversidens* is a valid species based on the configuration of the P<sup>3</sup> and M<sup>1</sup> and by its association in a fossil deposit with extinct mammals. Therefore, any comments in this paper regarding the absence of endemic Carnivora on Cuba are the opinion of Morgan and Ray, whereas Arredondo regards *Cubacyon* as part of Cuba's late Pleistocene fauna.

NEW AMPHIPODA FROM THE SOUTHERN OCEAN,  
WITH PARTIAL REVISIONS OF THE  
ACANTHONOTOZOMATIDAE AND  
PARAMPHITHOIDAE

Les Watling and Heather Holman

*Abstract.*—Six new species and 1 new genus of Acanthonotozomatidae, 2 new species of Paramphithoidae and 1 new species of Stegocephalidae are described from Antarctic waters, chiefly of the Scotia Sea region. New revisions are offered for the acanthonotozomatid genera *Acanthonotozomella*, *Iphimedia*, *Iphimediella*, and *Pseudiphimediella* and the paramphithoid genera *Epimeria* and *Parepimeria*.

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With this paper we begin a series of studies on the Amphipoda from the Scotia Sea region of the Southern Ocean. This and the following papers will be directed toward the redescription of poorly known or incorrectly described species as well as the description of new species. To facilitate the redescription of older taxa and the revision of generic concepts we have borrowed much type-material and would like to thank the following persons and institutions for making specimens available to us: Dr. Denise Bellan-Santini, Station Marine d'Endoume; Ms. Joan Ellis, British Museum (Natural History); Ms. Elizabeth Louw, South African Museum; Dr. H.-E. Gruner, Zoologisches Museum der Humboldt—Universität zu Berlin; and Dr. Roy Olerod, Swedish Museum of Natural History. Additional material was sent to us for examination by Dr. R. Y. George and Dr. L. D. McKinney. We would like to express our gratitude to Ms. Patrice Rossi whose pencil and ink illustrating capabilities saved us much time and effort, and to Dr. J. L. Barnard for his critical examination of our manuscript.

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Acanthonotozomatidae

*Acanthonotozomella* Schellenberg

*Acanthonotozomella* Schellenberg, 1926:332.

*Paracanthonotozoma* Bellan-Santini:1972:177 (new synonymy).

*Type-species.*—*Acanthonotozomella alata* Schellenberg, 1926 (original designation).

*Diagnosis* [modified from Schellenberg (1926) and J. L. Barnard (1969)].—Body with numerous processes; telson wide, entire to emarginate; antenna 1 shorter than antenna 2, accessory flagellum absent; upper lip distally grooved; mandible incisor multi-toothed, molar poorly developed, with setal row extending between incisor and molar; inner plate of maxilla 1 not minute, few setae distally, palp biarticulate, reaching end of outer plate; maxilliped well-developed, palp 4-articulate, article 2 not expanded or produced; gnathopods 1 and 2 simple, alike; coxae 1 and 3 subrectangular, coxa 2 shorter than either coxa 1 or 3; coxae 5–7 rounded.

*Remarks*.—The genus *Acanthonotozomella*, as diagnosed above, is considered here to contain the following species: *A. alata*, Schellenberg 1926; *A. trispinosa* (Bellan-Santini 1972), originally described as the type-species of the genus *Paracanthonotozoma*; and *A. barnardi* n. sp., described below. Recently, Bushueva (1978) described the species *A. pushkini*, but as will be discussed below, we believe this species represents a distinct genus, intermediate in position to *Acanthonotozomella* and *Acanthonotozomoides*, to which we will give the name *Acanthonotozomoposis*. The genera, *Acanthonotozoma*, *Acanthonotozomoides*, *Acanthonotozomella* and *Acanthonotozomoposis* are united by their common possession of the following features: gnathopods 1 and 2 simple; maxilla 1 palp 2-articulate; maxilliped palp exceeds outer plate, 4-articulate, article 2 not produced or expanded. The characters which distinguish these genera are given in Table 1. *Acanthonotozomoides* and *Acanthonotozomella* can be readily characterized by features of the body as well as mouthparts. Bushueva (1978) used the shape of coxae 1–3, maxilliped palp article 2 not produced along article 3 and pereopod 7 larger than 5 and 6 to assign her species *pushkini* to *Acanthonotozomella*. However, the presence of a minute inner plate and expanded palp article 2 on maxilla 1, lack of acute body processes, form of mandible incisor and similarity of coxae 1 and 2 distinguish Bushueva's species from all others in Table 1 and warrants, in our opinion, the erection of a new genus.

*Acanthonotozomella trispinosa* (Bellan-Santini), new combination

*Paracanthonotozoma trispinosum* Bellan-Santini, 1972:177, pl. 6.

*Diagnosis*.—Coxae 1 and 3 anteroventral corners produced; antenna 1 peduncle article 1 with distal tooth; mandible seta row short; pereopods 5, 6 and 7 alike, all with excavate posterior margins, lobe above excavation subacute.

*Remarks*.—Comparison of the type-specimen of *A. alata* with the illustrations of *A. trispinosa* revealed many similarities, especially in dorsal armature. They were found to differ in the following features: coxa 2 is distally rounded in *A. alata* and is distally subacute in *A. trispinosa*; antenna

Table 1.—Comparison of the four genera of Acanthonotozomatidae which constitute the *Acanthonotozoma*-complex.

	<i>Acanthonotozoma</i> Boeck 1876	<i>Acanthonotozomoides</i> Schellenberg 1931	<i>Acanthonotozomella</i> Schellenberg 1926	<i>Acanthonotozomopsis</i> n. gen.
Component species	9 species	<i>A. oatesi</i> (K. H. Barnard 1930) <i>A. subtilioralis</i> Schellenberg 1931	<i>A. alata</i> Schellenberg 1926 <i>A. barnardi</i> n. sp. (Bellan-Santini 1972)	<i>A. pushkini</i> Bushueva 1978
Body processes	Acute	Acute	Acute	Bluntly rounded
Coxae 1–3	Progressive increase in size posteriorly	Progressive increase in size posteriorly	Coxa 2 different shape than 1 and 3, shorter than or equal to 3	Coxa 2 shorter than 3
Coxa 4 posterior margin	With protuberance	With protuberance	With protuberance	Without protuberance
Mandible seta row	Absent	Present	Present	Present
Mandible incisor	Narrow	Narrow	Narrow	Broad
Maxilla 1 inner plate	Not minute	Minute	Not minute	Minute
Maxilla 1 palp	Narrow	Narrow	Narrow	Expanded
Maxilliped palp article 2	Not produced; linear	Produced; linear	Not produced; linear	Not produced; broadened
Gnathopods 1 and 2	Dissimilar	Similar	Similar	Similar
Telson	Cleft	Entire	Entire to emarginate	Entire

1 peduncle article 1 bears a dorsal tooth in *A. trispinosa* but such a tooth is absent in *A. alata*; the hind margin of pereopods 5–7 basis is rounded above the excavation in *A. alata* but forms an acute lobe in *A. trispinosum*. Since the specimens also differed strongly in size (*A. alata*, 3 mm; *A. trispinosa*, 12 mm) it is possible that the above differences are size-related and the two species are synonymous. Also see comparisons in Table 1.

*Acanthonotozomella barnardi* n. sp.

Figs. 1–3

*Material*.—Holotype: *Eltanin* Cruise 9, Sta. 740, 18 Sept. 1963, 56°06'S, 66°19–30'W, 384–494 m, 1 ♂ (USNM 173583).

*Diagnosis*.—Pleonite 3 with single, dorsal, upright tooth; coxa 1 rectangular distally, not produced acutely at anterodistal corner; coxa 2 rectangular distally; mandible with multidenticulate incisor and poorly developed molar with row of more than 30 setae between incisor and molar; bases of pereopods 5 and 6 similar, anterior and posterior margins almost parallel with posterodistal corner extending downward in a smooth lobe; pereopod 7 distinct from pereopods 5 and 6, posterior margin of basis excavate distally, posterodistal corner extended downward as a slender lobe.

*Description*.—Head, without rostrum, shorter than pereonite 1. Integument of body covered with small conelike papillae giving rough appearance. Pereonite 1 to urosomite 1 each with single dorsal projection extending upward and posteriorly. Projection on pereonite 1 forming upright, truncate keel with slight posterior extension. Projections on pereonites 2–6 in form of upright, posteriorly projecting teeth on posterior part of each somite, increasing in size with successive somite. Pleonite 3 bearing single upright keel, posterior part of which forms subacute apex without projecting over following somite. (Exact structure of tooth on urosomite 1 uncertain as it was broken on this specimen.) Pleurae of pereonites 1–7 all projecting outward and posteriorly. Epimeral plates 1–3 each with lateral tooth on posterior margin. Distal margin of epimeral plate 1 forming subacute point. Distal margin of epimeral plates 2 and 3 rounded anteriorly, more angular posteriorly. Coxae 1–3 rectangular distally. Coxa 1 slightly excavate anteriorly. Coxa 2 more slender distally and shorter than coxa 1 or 3. Coxa 4 lower margin crescentic. Coxae 5–7 rounded posteriorly.

Rostrum with raised lateral edges, shorter than first peduncle article of antenna 1. Ocular bulge pronounced. Antenna 1 peduncle article 1 equal in length to combined lengths of articles 2 and 3, accessory flagellum absent. Article 4 of antenna 2 subequal to article 5. Upper lip distinctly grooved with fine hairs along edge to either side of groove. Mandible multidenticulate; toothed accessory plate present on right mandible; molar poorly developed with row of approximately 34 setae between incisor and molar; palp

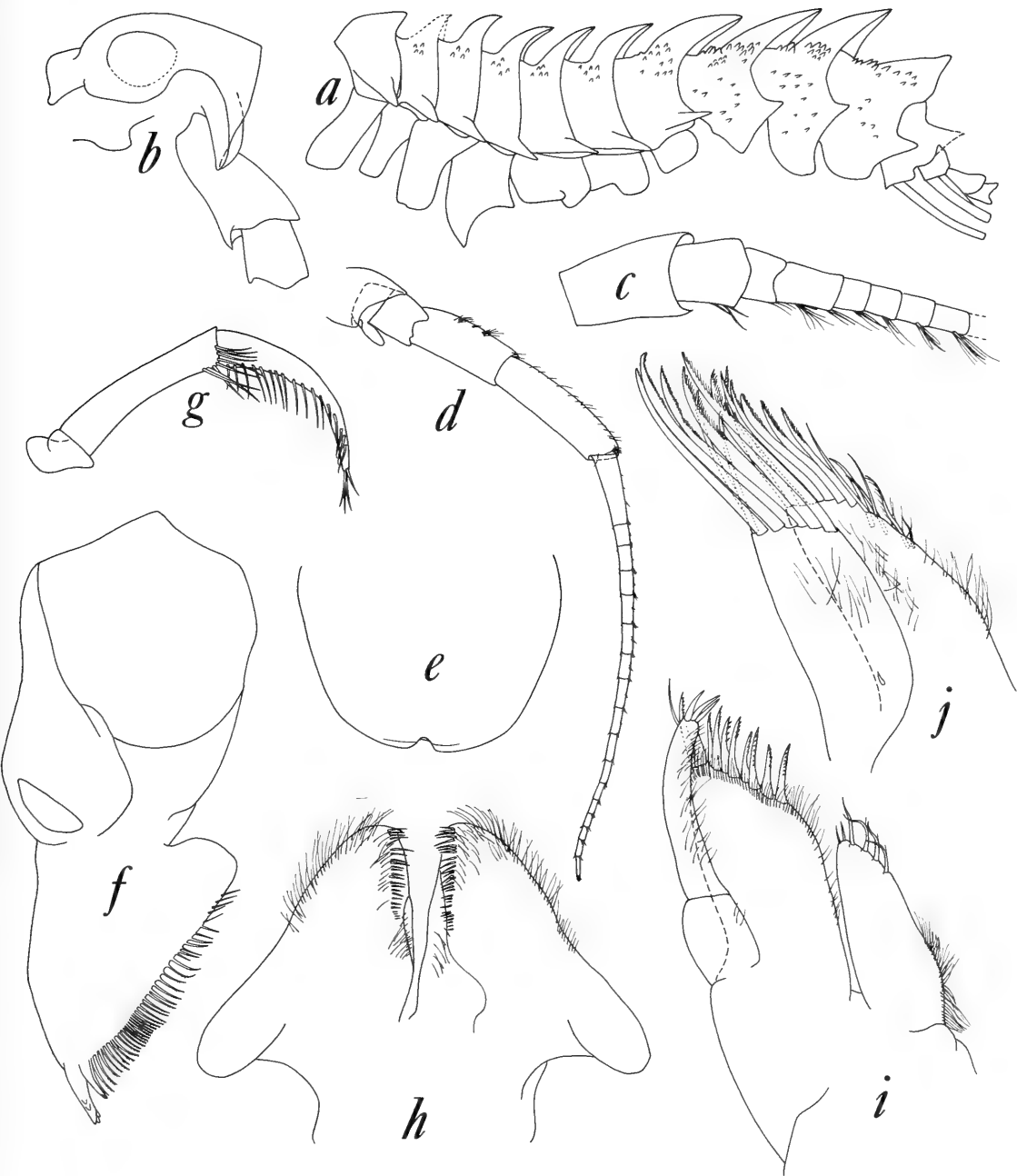


Fig. 1. *Acanthonotozomella barnardi*, male: **a**, Body, side view; **b**, Head; **c**, Antenna 1; **d**, Antenna 2; **e**, Upper lip; **f**, Mandible; **g**, Mandible palp; **h**, Lower lip; **i**, Maxilla 1; **j**, Maxilla 2.

articles 2 and 3 equal in length. Lower lip tapering distally and unnotched. Palp of maxilla 1 biarticulate and extending past outer plate; inner plate slender with 2 short spines and 4 longer setae on distal margin. Maxilla 2 inner and outer plates subequal in length, serrate setae on distal margins of both, somewhat longer on outer plate. Maxilliped palp 4-articulate, articles 1–3 equal in length, article 4 slightly shorter and bearing approximately 5





Fig. 2. *Acanthonotozomella barnardi*, male: a, Maxilliped; b, Gnathopod 1; c, Gnathopod 2; d, Telson.

setae on tip. Gnathopods simple and alike; carpus slightly longer than propodus, dactyl half length of propodus. Pereopods 5 and 6, anterior and posterior margins of basis parallel with posterodistal corner, extending downward as rounded lobe past distal margin of ischium. Pereopod 7 basis excavate behind with posterodistal corner extending downward as a subacute lobe past distal margin of ischium. Telson appears to be entire, poor condition of distal margin makes this uncertain. No uropods were intact.

*Etymology*.—This species is named in honor of Dr. J. L. Barnard.

*Distribution*.—Known only from the type-locality.

*Remarks*.—This species differs from *A. alata* and *A. trispinosa* primarily by having a single dorsal tooth on pleonite 3 (vs. 2 teeth), a distally truncate coxa 2 (vs. round or subacute), pereopods 5 and 6 hind margin not excavate (vs. excavate), and a long seta row (ca. 30 setae) on the mandible (vs. 8–10 setae).

### *Acanthonotozomopsis* n. gen.

*Type-species*.—*Acanthonotozomella pushkini* Bushueva 1978.

*Diagnosis*.—Body with blunt dorsal and lateral processes; coxa 2 shorter than but similar in shape to coxae 1 and 3; coxa 4 triangular, without posterior protuberance; mandible incisor broadened, seta row long; maxilla 1

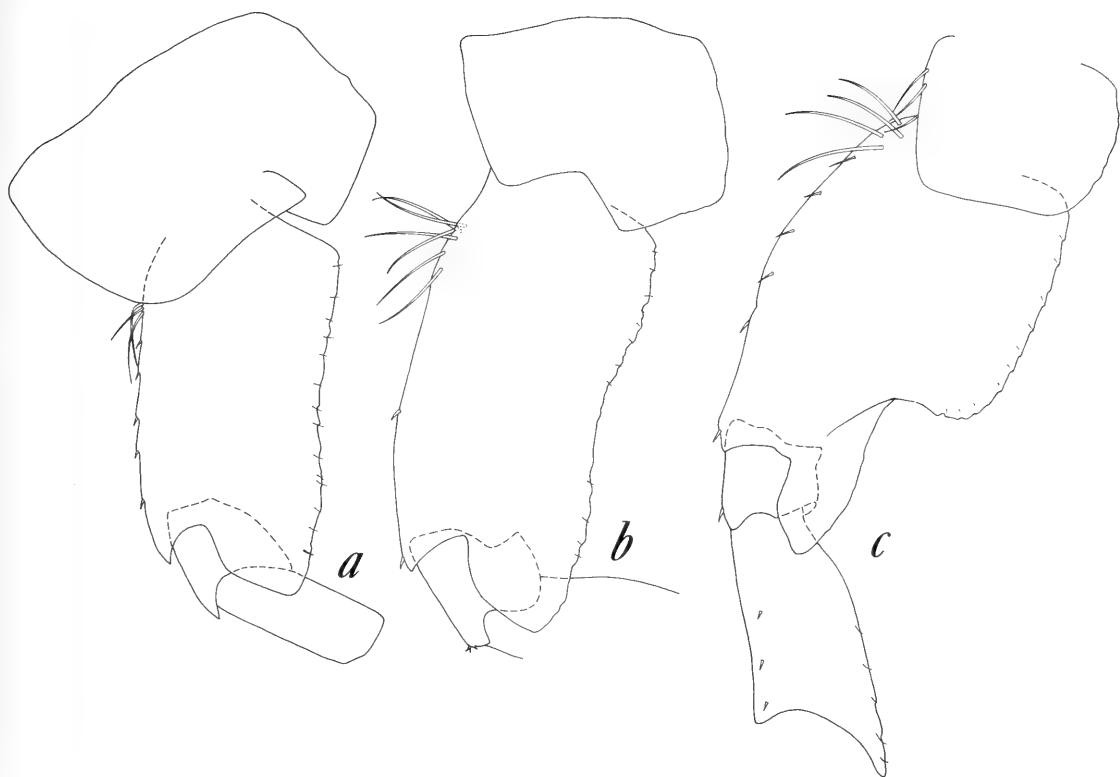


Fig. 3. *Acanthonotozomella barnardi*, male: a, Pereopod 5; b, Pereopod 6; c, Pereopod 7.

inner plate minute, palp article 2 expanded; maxilliped palp article 2 broad, not produced along article 3; gnathopods simple, of similar shape; telson entire.

*Remarks.*—The distinctiveness of this genus is discussed in the remarks for *Acanthonotozomella* and its features listed in Table 1.

### *Iphimedia* Rathke

*Iphimedia* Rathke, 1843:85.

*Panoploea* Thomson, 1880:2.—Karaman and Barnard, 1979:110.

*Cypsiphimedia* K. H. Barnard, 1955:87 (new synonymy).

*Type-species.*—*I. obesa* Rathke 1843.

*Diagnosis.*—Upper lip entire or slightly emarginate; maxilla 1 palp biarticulate, of variable length; maxilliped palp exceeding outer plate, 3-articulate, article 2 produced medially along article 3; gnathopod 1 chelate; gnathopod 2 chelate or subchelate; telson variably emarginate or incised.

*Remarks.*—At their extremes, *Iphimedia* and *Panoploea* were significantly different from each other. Karaman and Barnard (1979), when synonymizing the two genera, showed there was a continuous variation in shape and size of upper and lower lips, mandible and maxilla 1 palp. Krapp-

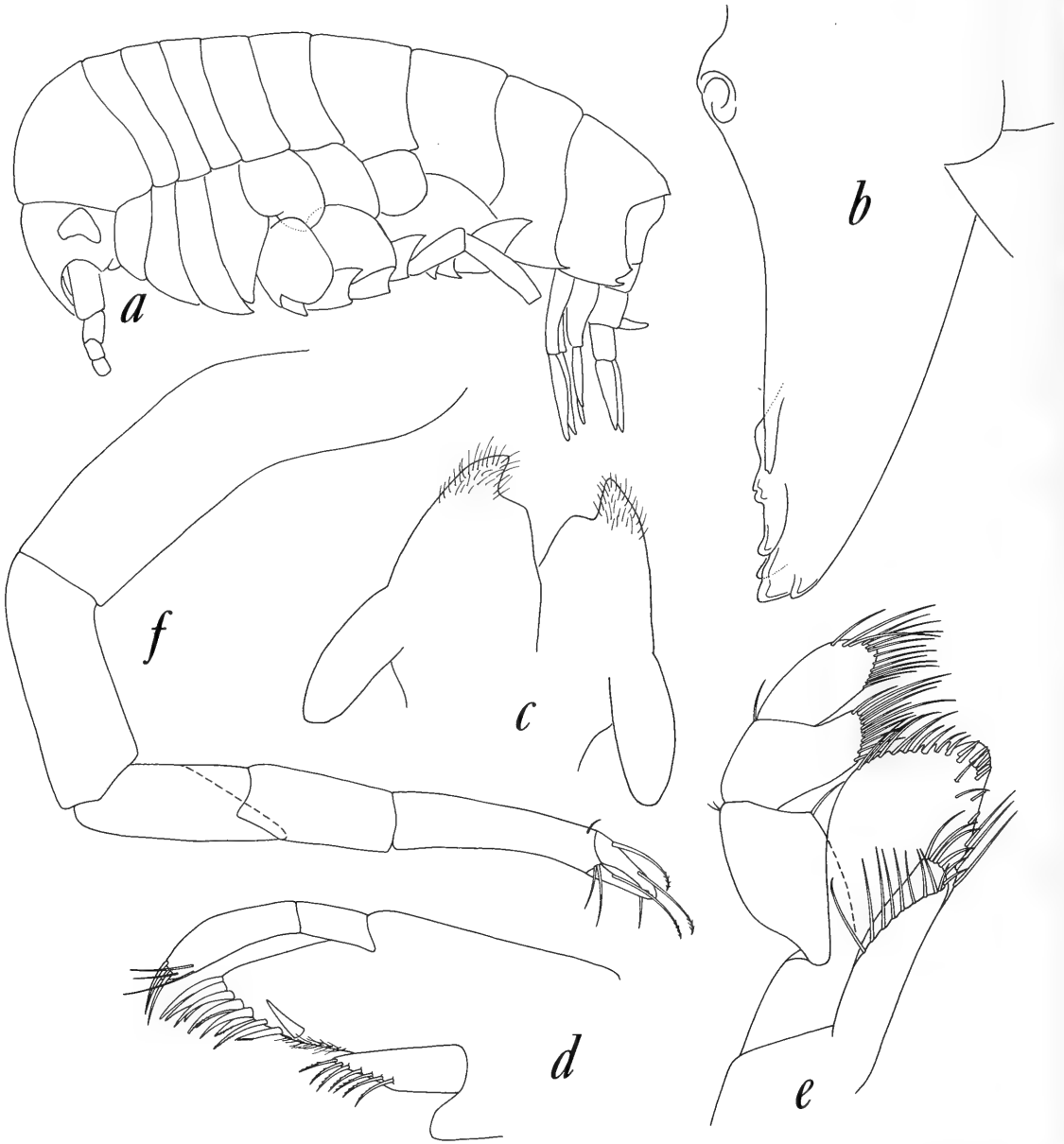


Fig. 4. *Iphimedia gibba*: a, Body, side view; b, Mandible; c, Lower lip; d, Maxilla 1; e, Maxilliped; f, Gnathopod 1.

Schickel (1976) noted that the palp of maxilla 1 of *I. minuta* changed in length with size of the individual. Karaman and Barnard (1979) further distinguished *Iphimedia* from the closely related *Cypsiphimedia* on the basis of the latter possessing an enlarged first pereonite and lacking dorsal body processes (but see later). As with the palp of maxilla 1 and the strength of the mandible, it can be shown that there is also a gradation in size of pereonite 1, ranging from equal to pereonite 2 in *I. obesa* Rathke, as long as pereonites 2 and 3 in *I. spinosa* (Thomson), to as long as pereonites 2–4 in

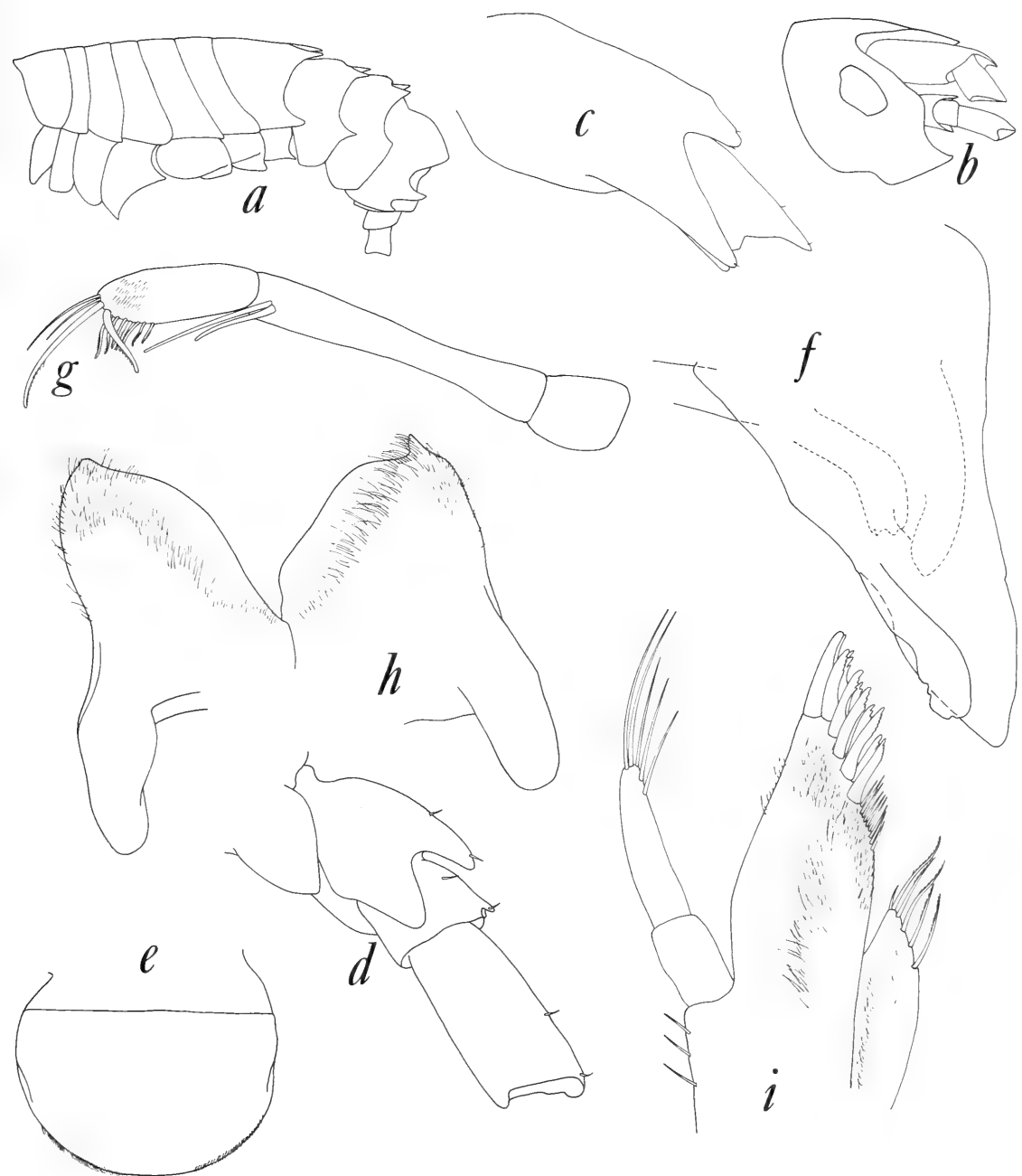


Fig. 5. *Iphimedia magellanica*, female: **a**, Body, side view; **b**, Head; **c**, Antenna 1 peduncle articles 1 and 2; **d**, Antenna 2 peduncle; **e**, Upper lip; **f**, Right mandible; **g**, Mandible palp; **h**, Lower lip; **i**, Maxilla 1.

*I. eblanae* (Bate). Additionally, the number and shape of dorsal processes range from 4 pairs of short teeth (*I. obesa*), to 3 pairs of long and slender teeth (*I. joubini*), to 3 pairs of short processes (*I. spinosa*), to a single minute pair of processes (*I. excisa*). Thus, the species assigned to *Cypsi-phimedia* by Karaman and Barnard (1979) are not outside the concept of *Iphimedia* as diagnosed above. This genus, more than any other in the

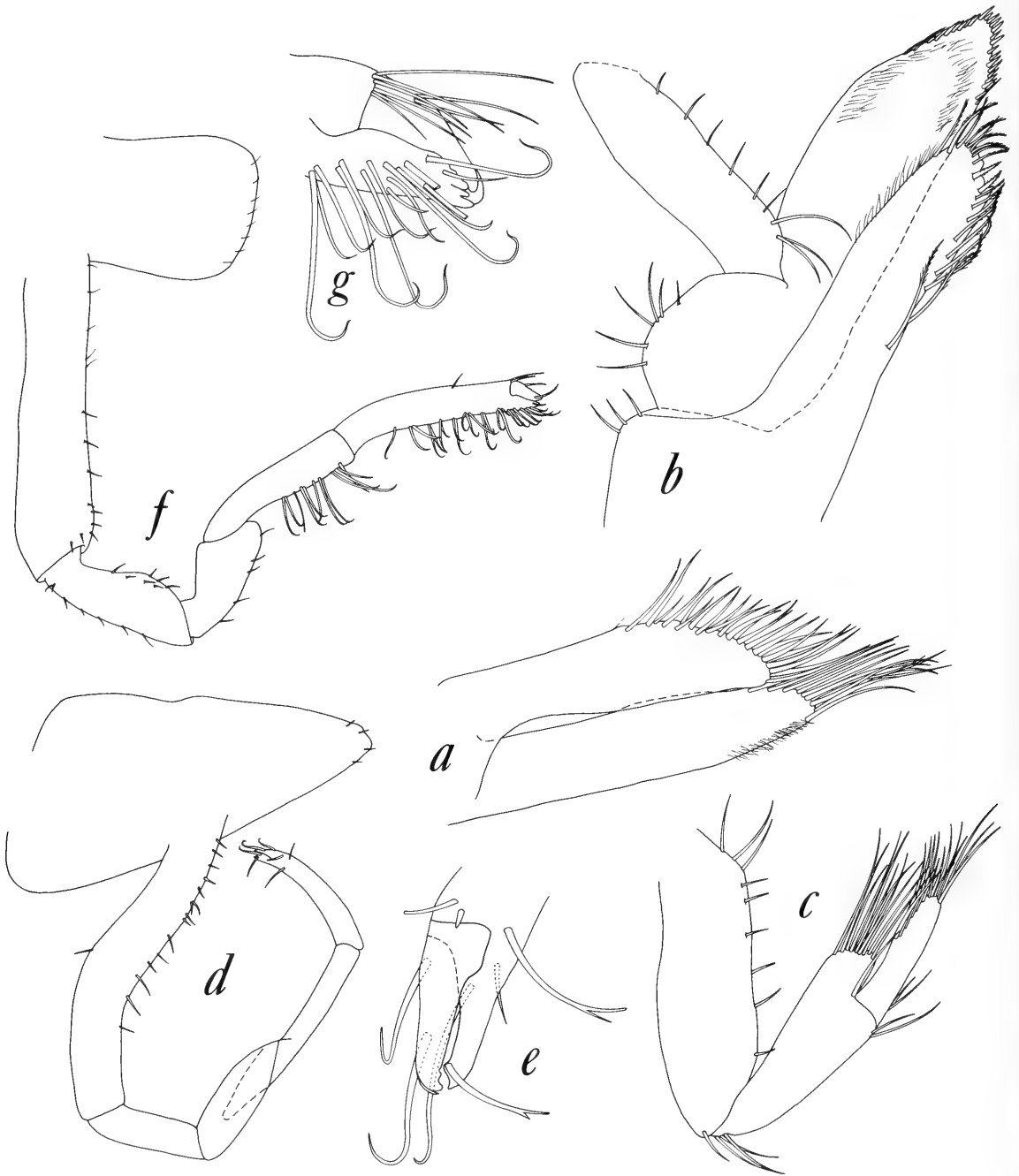


Fig. 6. *Iphimedia magellanica*, female: a, Maxilla 2; b, Maxilliped without palp; c, Maxilliped palp; d, Gnathopod 1; e, Gnathopod 1 propodus fixed finger and dactyl; f, Gnathopod 2; g, Gnathopod 2 propodus fixed finger and dactyl.

family, is characterized by a series of gradational characters. In our opinion the genus needs a further re-examination and perhaps should be subdivided into more discrete units. It is also one of the few acanthonotozomatid genera to be extensively represented outside polar waters. The genus as presently constituted contains the following species: *I. capicola* K. H. Barnard, *I.*

*discreta* Stebbing, *I. eblanae* (Bate), *I. excisa* (K. H. Barnard), *I. gibba* (K. H. Barnard), *I. gladiolus* K. H. Barnard, *I. grossimana* Ledoyer, *I. haurakiensis* Hurley, *I. imparilabia* n. sp., *I. joubini* (Chevreux), *I. jugoslavica* Karaman, *I. macrocystidis* (K. H. Barnard), *I. magellanica* n. sp., *I. minuta* (Sars), *I. multidentata* (Schellenberg), *I. obesa* Rathke, *I. orchestimana* Ruffo, *I. pacifica* Stebbing, *I. rickettsi* (Shoemaker), *I. spinosa* (Thomson), *I. stegosaura* (Griffiths).

*Iphimedia gibba* (K. H. Barnard), new combination

Fig. 4

*Cypsiphimedia gibba* K. H. Barnard, 1955:88, fig. 43.

*Material*.—Holotype: South African Museum No. 10318.

*Diagnosis* (emended from K. H. Barnard, 1955).—Body with minute paired dorsal processes on pleonite 3, otherwise smooth dorsally; pereonite 1 expanded, head directed ventrally; lower lips apically notched; maxilla 1 palp longer than outer plate; gnathopod 2 propodus ovate.

*Description*.—The following supplements the description given by K. H. Barnard (1955). Body with pair of minute dorsal processes on pleonite 3. Epimeral plate 3 posteroventral corner with 2 teeth. Mandible accessory plate minute, feebly bidentate. Maxilla 1 palp longer than outer plate. Maxilliped palp 3-articulate; article 2 expanded and produced along article 3.

*Remarks*.—Our re-examination of the holotype has shown the mouthparts of this species to be typical of *Iphimedia*. Also, contrary to the statement of Karaman and Barnard (1979) the palp of maxilla 1 is in fact longer than the outer plate. The size of pereonite 1 is not beyond the range otherwise seen for *Iphimedia* and its ties to the genus appear to be strengthened by the presence of minute dorsal processes on pleonite 3.

*Iphimedia magellanica* n. sp.

Figs. 5–7

*Material*.—Holotype. *Eltanin* Cruise 11, Sta. 977, 13 Feb. 1964, 52°32'S, 63°53'W, 299 m, 1 ♀ with eggs (USNM 173584), 6 mm. Paratypes: same station, 4 juveniles (USNM 173585).

*Diagnosis*.—Body with short, paired dorsal processes on pereonite 7 and pleonites 1 and 2; pleonites 1–3 with mid-dorsal keel; pereopod 7 basis posterior margin with 3 teeth, coxa with single posterodistal tooth.

*Description*.—Body with 3 pairs dorsal processes, all short and somewhat curved downward; pleonites 1 and 2 with short mid-dorsal keel; pleonite 3 mid-dorsal keel enlarged. Pleurae on pereopods 5–7 extend as posteriorly-directed acute processes. Epimeral plates 1 and 2 with small posterodistal tooth. Hind margin of epimeral plate 3 with 2 teeth. Head lateral margin

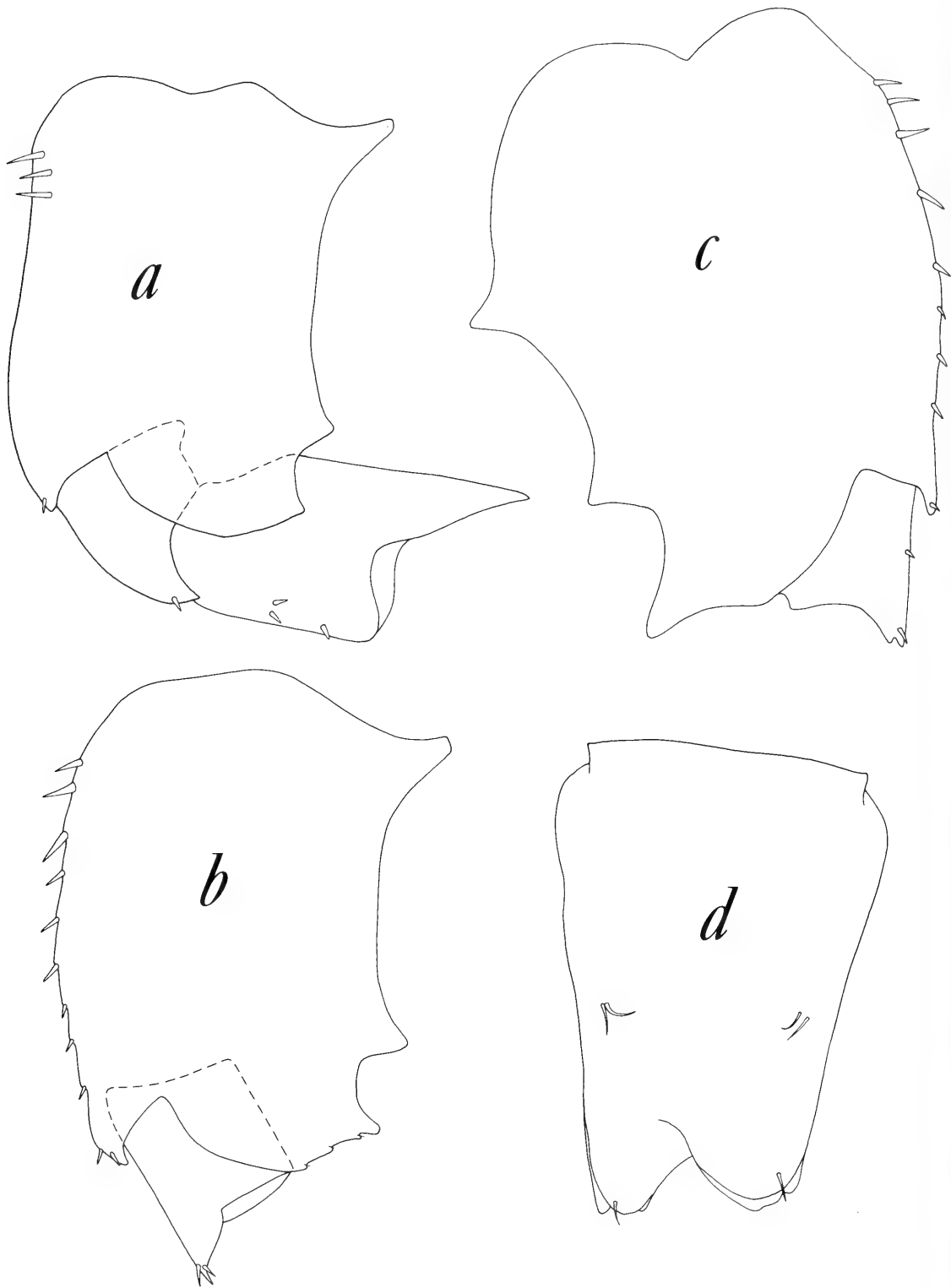


Fig. 7. *Iphimedia magellanica*, male: **a**, Pereopod 5; **b**, Pereopod 6; **c**, Pereopod 7; **d**, Telson.

slightly produced as acute process distally; rostrum extends nearly length of first peduncle article of antenna 1. Ventral tooth of antenna 1 peduncle article 1 extends to end of peduncle article 2, dorsal tooth small. Antenna 2 peduncle article 3 with short lateral and dorsal apical teeth. Upper lip broadly rounded, with paired ventrolateral groups of fine setae. Left mandible with blunt, smooth incisor, accessory plate weakly toothed; right mandible without accessory tooth; palp article 2 twice length of article 3, armed with only 2 distal setae; third palp article with setae on ventral margin of distal third of article. Lower lip variably incised. Maxilla 1 palp biarticulate, not reaching end of outer plate; inner plate small, with 5 long setae; outer plate with 11 stout setae apically. Maxilla 2 slender, inner and outer plates subequal in width; distal setae on outer plate only slightly longer than on inner plate. Maxilliped palp 3-articulate, article 2 produced medially along article 3, article 1 longer than article 2, third article elongate, distally blunt, two-thirds the length of article 2; inner plate narrow, armed with plumose setae along distal half of inner margin; outer plate apically subacute.

Gnathopod 1 chelate; coxa distally subacute, with 4 short setae; basis with scattered short setae along inner margin; dactyl equal in size to fixed finger of propodus, with 2 long, blunt setae; propodus fixed finger with 4 long setae, 2 of which are distally forked. Gnathopod 2 chelate; coxa distally quadrate; article 6 longer than article 5. Pereopods 5–7, basis posterior margin with 3 teeth, 1 located dorsally and 2 ventrally. Uropod 1 rami subequal; uropod 2 outer ramus shorter than inner. Telson shallowly cleft.

*Etymology*.—Name derived from Magellanic zoogeographic province.

*Distribution*.—Known only from locality listed above.

*Remarks*.—This species is distinctive among species of *Iphimedia* in its possession of only 3 pairs of short, downwardly curving dorsal processes and single, upright keel on pleonite 3 in combination with the form of the posterior pereopods and coxae. The general body form suggests affinities with *I. multidentata* and *I. macrocystidis*; however the absence of paired posterior teeth on coxa 7 and the number of teeth on pereopod 7 basis hind margin readily distinguish *I. magellanica* from both species.

*Iphimedia imparilabia* n. sp.

Figs. 8, 9

*Material*.—Holotype: *Eltanin* Cruise 6, Sta. 340, 3 Dec. 1962, 53°07–08'S, 59°21–23'W, 567–578 m, 1 ♂, 7 mm (USNM 173586).

*Diagnosis*.—Body with short, paired dorsal processes on pereonite 7 and pleonites 1 and 2, and with mid-dorsal keel on pleonite 3; pereopod 7 coxa posterior margin rounded, basis posterior margin slightly concave distally, without conspicuous teeth; maxilla 1 palp biarticulate, short; maxilliped palp article 3 very short.



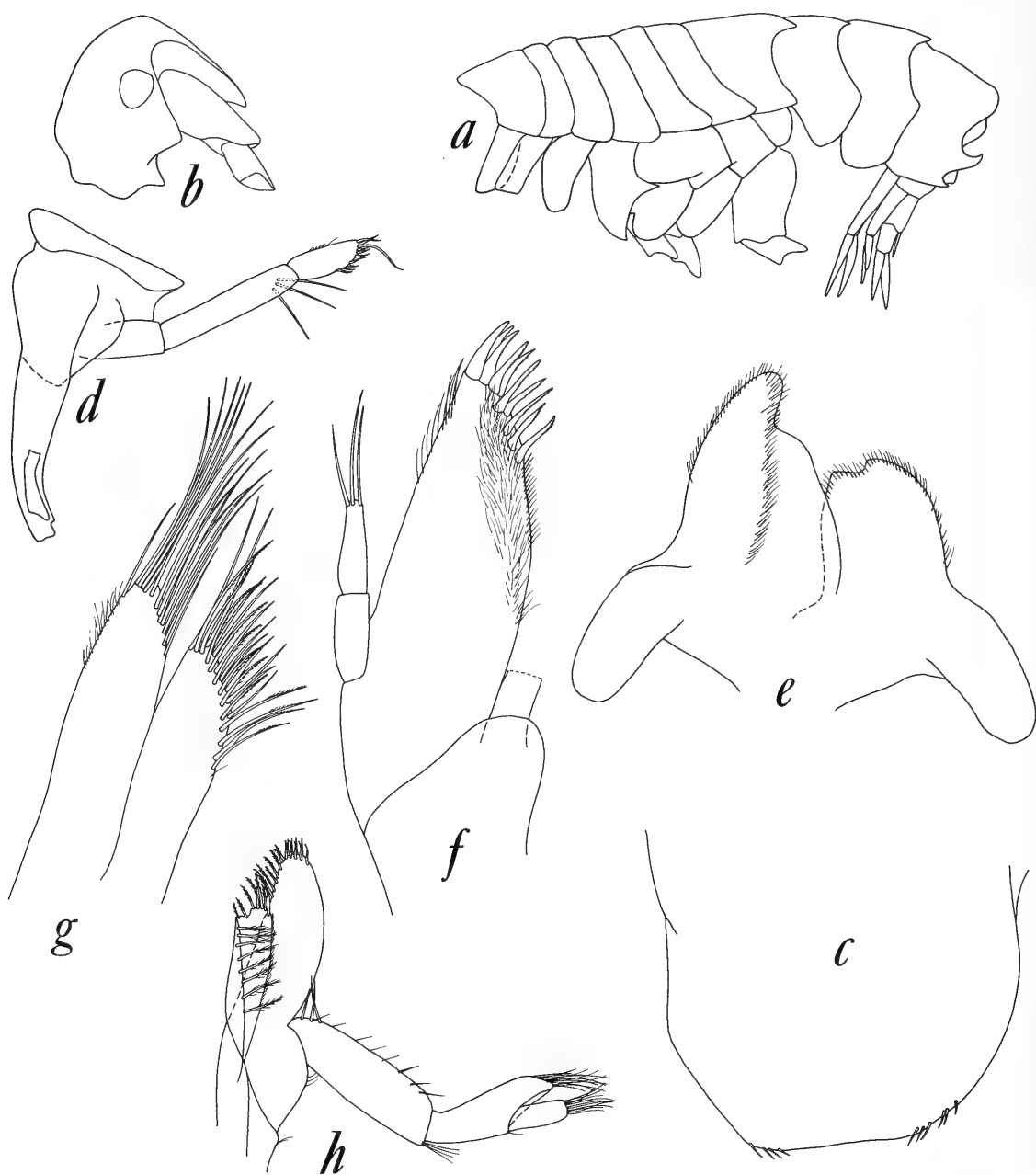


Fig. 8. *Iphimedia imparilabia*, male: **a**, Body, side view; **b**, Head; **c**, Upper lip; **d**, Mandible; **e**, Lower lip; **f**, Maxilla 1; **g**, Maxilla 2; **h**, Maxilliped.

**Description.**—Head interantennal angle subacute, anteroventral corner with short subacute process. Body with short, paired dorsal processes on pereonite 7 and pleonites 1 and 2; mid-dorsal keel strongly developed on pleonite 3. Pleurae on pereonites 5–7 not conspicuously produced. Epimeral plates 1 and 2 without teeth at posterodistal corners; epimeral plate 3 with lateral and distal teeth on posterior margin. Coxa 2 subrectangular; coxa 7 rounded posteriorly.

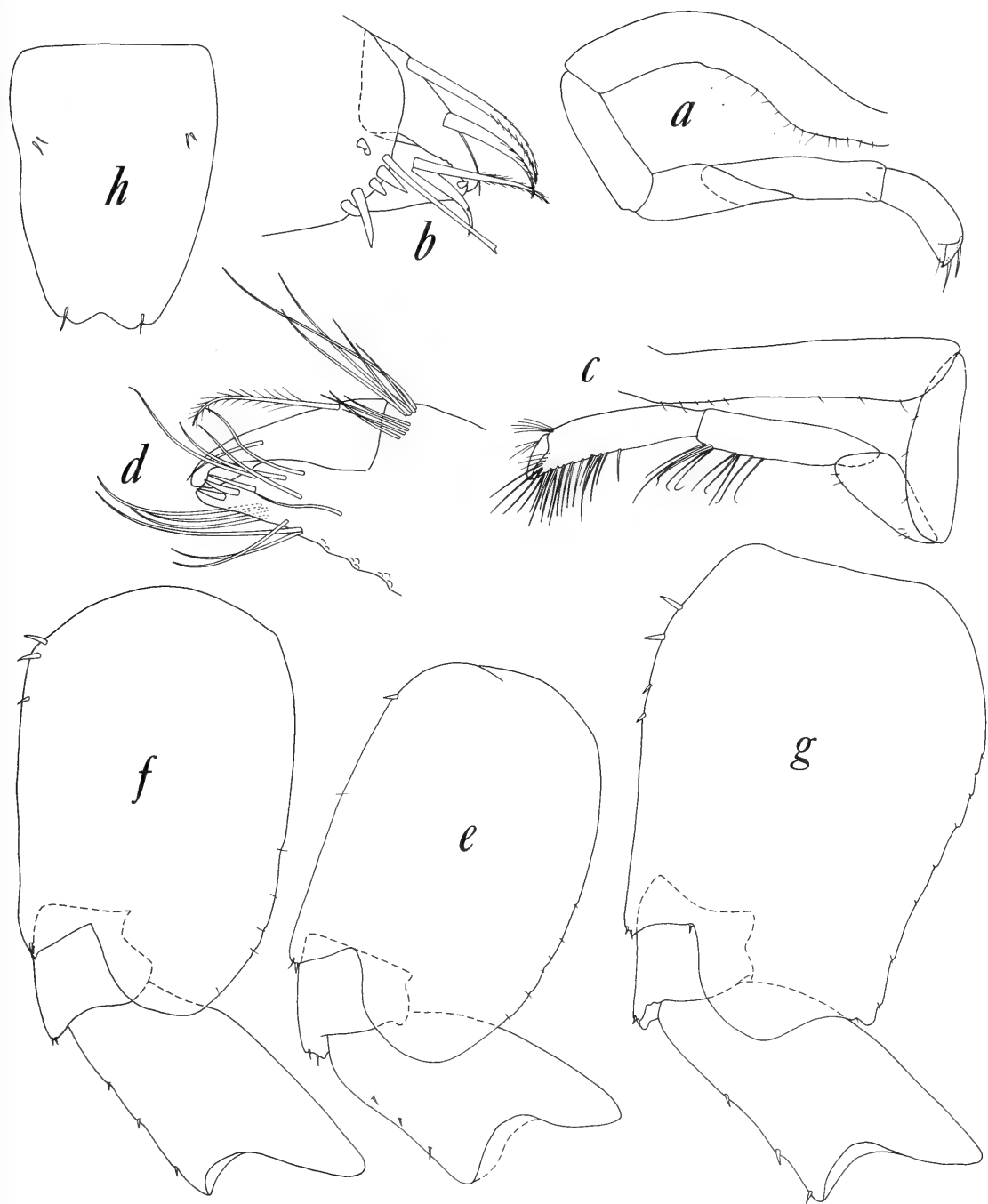


Fig. 9. *Iphimedia imparilabia*, male: **a**, Gnathopod 1; **b**, Gnathopod propodus fixed finger and dactyl; **c**, Gnathopod 2; **d**, Gnathopod 2 propodus fixed finger and dactyl; **e**, Pereopod 5; **f**, Pereopod 6; **g**, Pereopod 7; **h**, Telson.

Antenna 1 peduncle article 1 without major teeth on distal margin; peduncle article 2 with short, blunt dorsal tooth distally. Upper lip truncate distally, with paired groups of distolateral setae. Mandible incisor elongate, slightly spooned, accessory plate on left mandible elongate; palp article 2 with distal group of 3 setae; palp article 3 half length of article 2, with 9

distal setae. Lower lip lobes unequal in length distally, both incised. Maxilla 1 palp biarticulate, not reaching end of outer plate, articles subequal in length, outer plate 10 stout setae apically; inner plate broken. Maxilla 2 inner and outer plates subequal in width; outer plate bearing setae equal to three-fourths length of plate, much longer than those on inner plate. Maxilliped palp 3-articulate, article 2 produced medially along most of length of short article 3; outer plate without setae along outer margin; inner plate truncate distally.

Gnathopod 1 subchelate; article 6 shorter than 5; dactyl and propodus fixed finger shortened. Gnathopod 2 chelate; articles 5 and 6 subequal in length; article 6 with setae along distal half of ventral margin; fixed finger of propodus with dense cover of setae. Pereopod 5 and 6 basis posterodistal corner narrowly rounded. Pereopod 7 basis posterior margin distally concave, with few small serrations. Uropod 1 rami subequal, armed with short setae. Uropod 2 outer ramus shorter than inner, both with a few short setae. Uropod 3 rami sublanceolate, armed with short setae. Telson slightly emarginate, with terminal pair of setae.

*Etymology*.—The species name is derived from the Latin *impar*, meaning unequal and *labium* meaning lip, referring to the unequal lobes of the lower lip.

*Distribution*.—Known only from the type-locality.

*Remarks*.—The form of the dorsal body processes on this species closely resembles those of several other species such as *I. spinosa* and *I. capicola*; however, the following mouthpart features distinguish it from all other members of the genus: lower lip with unequal lobes; very short palp article 3 and lack of setae on outer plate outer margin on the maxilliped.

### *Iphimediella* Chevreux, new synonymy

*Iphimediella* Chevreux 1911.

*Pariphimediella* Schellenberg 1931 (part).

*Type-species*.—*I. margueritei* Chevreux 1912.

*Diagnosis* [modified from Barnard (1969)].—Antenna 1 accessory flagellum uniarticulate; epistome not broad, less than 3 times as wide as high; upper lip entire or weakly incised; mandible incisor elongate, not excessively thickened or broadened, oriented to cut in transverse plane; lower lip without inner lobes, distal apices generally subacute; maxilla 1 palp biarticulate, reaching end of outer plate; maxilliped palp 4-articulate, article 2 scarcely or not produced; gnathopods 1 and 2 chelate; telson slightly cleft.

*Remarks*.—Karaman and Barnard (1979) noted that only minor differences in the mandible and lower lip had been used by Schellenberg (1931) to separate *Pariphimediella* and *Iphimediella*. We do not agree with Karaman and Barnard, however, in including *Pseudiphimediella nodosa* Dana

and *Pariphimediella glabra* Schellenberg in the genus *Iphimediella* as presently defined. These two species have mouthparts which are more broadened and have mandible incisors which cut in the frontal plane as opposed to the transverse-plane orientation seen in *Iphimediella*. According to the above diagnosis, the genus *Iphimediella* is here considered to consist of the following species: *I. bransfieldi* K. H. Barnard, *I. cyclogena* K. H. Barnard, *I. margueritei* Chevreux, *I. rigida* K. H. Barnard, *I. imparidentata* (Bellan-Santini), *I. microdentata* (Schellenberg), *I. octodentata* (Nicholls), *I. serrata* (Schellenberg). The latter two may be synonymous as Nicholls (1938) evidently mistook Schellenberg's (1926) drawing of *I. serrata* to show only a single dorsal process on pleonite 3. In his text however, Schellenberg clearly stated: "Die 2 letzten Meso- und die 3 Metasomsegmente tragen dorsal je ein Paar grosse, nach ruckwärts gerichtete, annähernd gerade Zahne" (1926:328). We have not yet examined specimens of either species and thus are hesitant to synonymize the two at this time.

Key to species of *Iphimediella*

- 1. Pleonites with enlarged mid-dorsal carinae, paired dorsal processes not prominent ..... *I. imparidentata* (Bellan-Santini)
  - Pleonites with distinct paired dorsal processes ..... 2
- 2. Without paired dorsal processes on pleonite 3 ..... 3
  - With paired dorsal processes on pleonite 3 ..... 5
- 3. Paired dorsal processes meet to form a "U" dorsally, pleonite 3 with slightly projecting keel ..... *I. georgei*
  - Paired dorsal processes meet to form a "V" dorsally; pleonite 3 without a keel ..... 4
- 4. Coxa 1 smoothly rounded anteroventrally, pereopod 7 basis broadly rounded behind, hind margin smooth; upper lip incised ..... *I. bransfieldi* K. H. Barnard
  - Coxa 1 serrate or dentate below; pereopod 7 basis hind margin serrate and nearly parallel to anterior margin; upper lip entire *I. discoveryi* n. sp.
- 5. Paired dorsal processes on pereonites 6 and 7 and on pleonites 1–3 ..... 6
  - Paired dorsal processes on pereonite 7 and on pleonites 1–3 .... 7
- 6. Coxa 1 ventral margin concave, coxae 4–7 ventral and posterior margins coarsely serrate, almost dentate .. *I. serrata* (Schellenberg)
  - Coxa 1 ventral margin straight, coxae 4–7 ventral and posterior margins finely serrate ..... *I. octodentata* (Nicholls)
- 7. Coxa 7 posterior margin produced as an elongate process; pereopod 7 basis with 2 posterior teeth ..... *I. acuticoxa* n. sp.
  - Coxa 7 smoothly rounded behind, at most with small tooth; per-

- eopod 7 basis smoothly rounded with single small tooth at postero-distal corner ..... 8
8. Prominent medial tooth on antenna 1 peduncle article 1 extends well past third peduncle article; coxa 1 tapering distally, ventral margin narrowly bifid ..... *I. margueritei* Chevreux
- Teeth on antenna 1 peduncle article 1 not extending past third article; coxa 1 not tapering, smooth at anteroventral corner ..... 9
9. Paired dorsal teeth form a distinct “V” shape; mid-dorsal keel present on pleonites 1–3, additional upright keel present on urosomite 1 ..... *I. rigida* K. H. Barnard
- Paired dorsal teeth do not form a “V” shape, no mid-dorsal keel present ..... 10
10. Dorsal processes short, stubby; telson only shallowly emarginate; upper lip entire ..... *I. microdentata* (Schellenberg)
- Dorsal processes elongate, slender; telson distinctly cleft; upper lip incised ..... *I. cyclogena* K. H. Barnard

*Iphimediella georgei* n. sp.

Figs. 10, 11

*Material*.—Holotype: *Islas Orcadas* Cruise 19, Sta. 7, 8 Mar. 1979, 62°18.9'S, 55°13'W, 610 m, 1 ♀ (28 mm) with eggs (USNM 173587). Paratypes: *Eltanin* Cruise 27, Sta. 1924, 27 Jan. 1967, 75°11'S, 176°13'W, 728–732 m, 2 juveniles (USNM 173588).

*Diagnosis*.—Body with paired dorsal processes on pereonite 7 and pleonites 1 and 2; pleonite 3 with keel only, produced slightly backward into acute tooth; coxa 1 anteroventral margin rounded, posteroventral margin drawn downward into anteriorly directed hook.

*Description*.—Three pairs dorsal processes meet mid-dorsally to form smoothly rounded “U.” Urosomite 1 with prominent mid-dorsal carina. Head anterolateral sinus with acute tooth above and longer acute tooth below. Coxa 1 anteroventral margin smoothly rounded; ventral margin becomes distinctly concave before forming anteriorly directed hook (easily broken) at posteroventral margin. Coxae 2 and 3 similar in shape to coxa 1 but more slender, less rounded anteriorly and less concave ventrally. Antenna 1 peduncle article 1 with prominent tooth projecting ventrally past distal margin of peduncle article 2, with 2 smaller teeth projecting laterally along midline; peduncle article 2 with teeth projecting along each lateral margin past distal margin of article 3; accessory flagellum uniarticulate. Antenna 2 longer than antenna 1 in female. Upper lip distinctly incised. Mandible tapering, incisor toothed; molar prominent and setose; palp 3-articulate; accessory plate on right mandible toothed, left accessory plate not as well developed. Lower lip entire, apices smoothly rounded, inner



Fig. 10. *Iphimediella georgei*, female: a, Body, side view; b, Antenna 1 peduncle and basal flagellar articles; c, Upper lip; d, Mandible; e, Mandible palp; f, Lower lip; g, Maxilla 1; h, Maxilla 2; i, Maxilliped without palp; j, Maxilliped palp.

lobes absent. Maxilla 1 palp biarticulate, exceeding length of outer plate, setae half way along inner margin; inner plate subtriangular with 18 plumose setae on inner margin. Maxilla 2 inner and outer plates subequal in width; setae extend along medial margin of inner plate. Maxilliped palp 4-articulate with fourth article minute, covered by setose, hoodlike extension of article

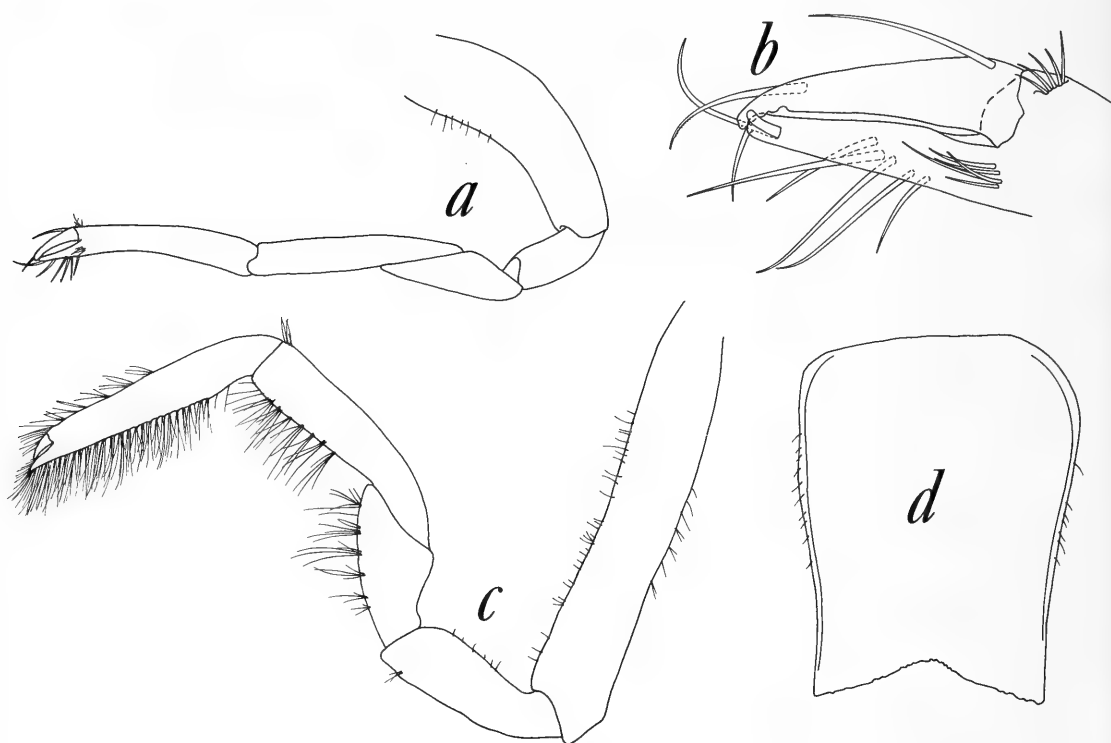


Fig. 11. *Iphimediella georgei*, female: a, Gnathopod 1; b, Gnathopod 1 propodus fixed finger and dactyl; c, Gnathopod 2; d, Telson.

3; palp article 2 distinctly expanded but not produced along article 3; palp article 3 longer than broad with plumose setae giving way to shorter, stouter setae along distal margin; inner plate with plumose setae along distal and medial margins. Gnathopods 1 and 2 chelate. Gnathopod 1 article 3 subequal to article 4 but less than  $\frac{1}{2}$  length of article 6; article 5 subequal to article 6. Gnathopod 2 article 3 longer than article 4,  $\frac{3}{4}$  length of article 6; article 5 subequal to article 6. Pereopods 5 and 6 basis posterior margin smoothly rounded proximally, drawn into a small tooth at posteroventral corner; posterior margin slightly serrate. Telson longer than wide, shallowly cleft; distal margin minutely irregular. Uropods 1 and 2 biramous. Uropod 1 peduncle longer than rami; outer ramus slightly shorter than inner. Uropod 2 peduncle slightly shorter than inner ramus; outer ramus shorter than inner. Uropod 3 either uniramous or missing inner ramus.

*Etymology*.—Named in honor of Dr. Robert Y. George.

*Remarks*.—This species can be easily distinguished by its dorsal armature. The only other *Iphimediella* species with 3 pairs of dorsal processes are *I. bransfieldi* and *I. discoveryi*. *I. georgei* differs from the latter 2 species in possessing a dorsal keel on pleonite 3. Additionally, the dorsal processes come together at the midline as a broadened “U” in *I. georgei* and as a “V” in *I. bransfieldi* and *I. discoveryi*. The mouthparts of *I. georgei* are

typically iphimeriellan with the expanded but not produced maxilliped palp article 2 being similar to that seen in *I. bransfieldi*.

*Iphimeriella acuticoxa* n. sp.

Figs. 12, 13

*Material*.—Holotype: *Eltanin* Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41'S, 54°43'W, 210–220 m, 1 juvenile, 5 mm (USNM 173589).

*Diagnosis*.—Body with paired elongate dorsal processes on pereonite 7 and pleonites 1–3; lower lip notched apically; maxilla 1 palp as long as outer plate; pereopod 7 posterior margin excavate between 2 large teeth; coxae 5–7 hind margins acutely produced.

*Description*.—Head anteroventral corner with shallow sinus bounded by pair of subacute processes. Body with paired elongate dorsal processes on pereonite 7 and pleonites 1–3, last 2 pairs being somewhat upturned. Pleonite 3 with slight mid-dorsal keel. Pleurae of pereonites 5–7 extend outward as acute processes. Epimeral plates 1–3 each with lateral and distal teeth on posterior margins. Coxae 1 and 2 distally rounded; coxae 5–7 postero-distal corners acutely produced.

Antenna 1 peduncle article 1 with 2 short dorsal teeth on distal margin, without ventral tooth; peduncle article 2 with dorsal, ventral and lateral teeth distally. Upper lip narrowly rounded, entire. Mandible elongate, with accessory plate on both left and right sides; molar a short, setose, flat-topped protuberance; palp article 2 with single distal seta, article 3 with covering of fine setae, longer setae on distal third of article. Lower lip with apical notch. Maxilla 1 palp biarticulate, exceeding outer plate, article 2 twice length of article 1; inner plate more than half length of outer plate, with 7 strong, plumose setae distally; outer plate with 5 stout setae at apex. Maxilla 2 inner and outer plates subequal in width; outer plate with long, simple setae at apex slightly longer than those on inner. Maxilliped palp 4-articulate, article 2 expanded but not produced along article 3, latter long and slender; palp article 1 only slightly longer than article 2, article 4 minute; outer and inner plates apically subacute; inner plate with setae only on distal half of medial margin.

Gnathopod 1 chelate, generally devoid of setae; dactyl partly fused to propodus; propodus finger bears 5 long plumose setae with backwardly-directed setules. Gnathopod 2 subchelate; article 6 longer than article 5, both articles sparsely setose; dactyl and fixed finger of propodus equal in size and shape. Pereopods 5–7, basis posterior margin excavate between dorsal and ventral teeth. Uropod 1 rami weak, outer ramus unarmed. Uropod 2 outer ramus shorter than inner. Telson shallowly V-cleft, with 2 terminal pairs of setae.

*Etymology*.—The name refers to the shape of coxa 7.





Fig. 12. *Iphimediella acuticoxa*, juvenile: a, Body, side view; b, Head; c, Antenna 1 peduncle articles 1 and 2; d, Antenna 2 peduncle articles 2-4; e, Upper lip; f, Left mandible with palp; g, Right mandible; h, Lower lip; i, Maxilla 1; j, Maxilla 2.

*Distribution*.—Known only from locality listed above.

*Remarks*.—This species is unique in the genus with respect to the acutely produced hind margins of coxae 5-7. Maxilliped palp article 2 is expanded medially and slightly produced; however the overall aspect of the palp is more closely related to several other *Iphimediella* species than it is to species of *Iphimedia*.

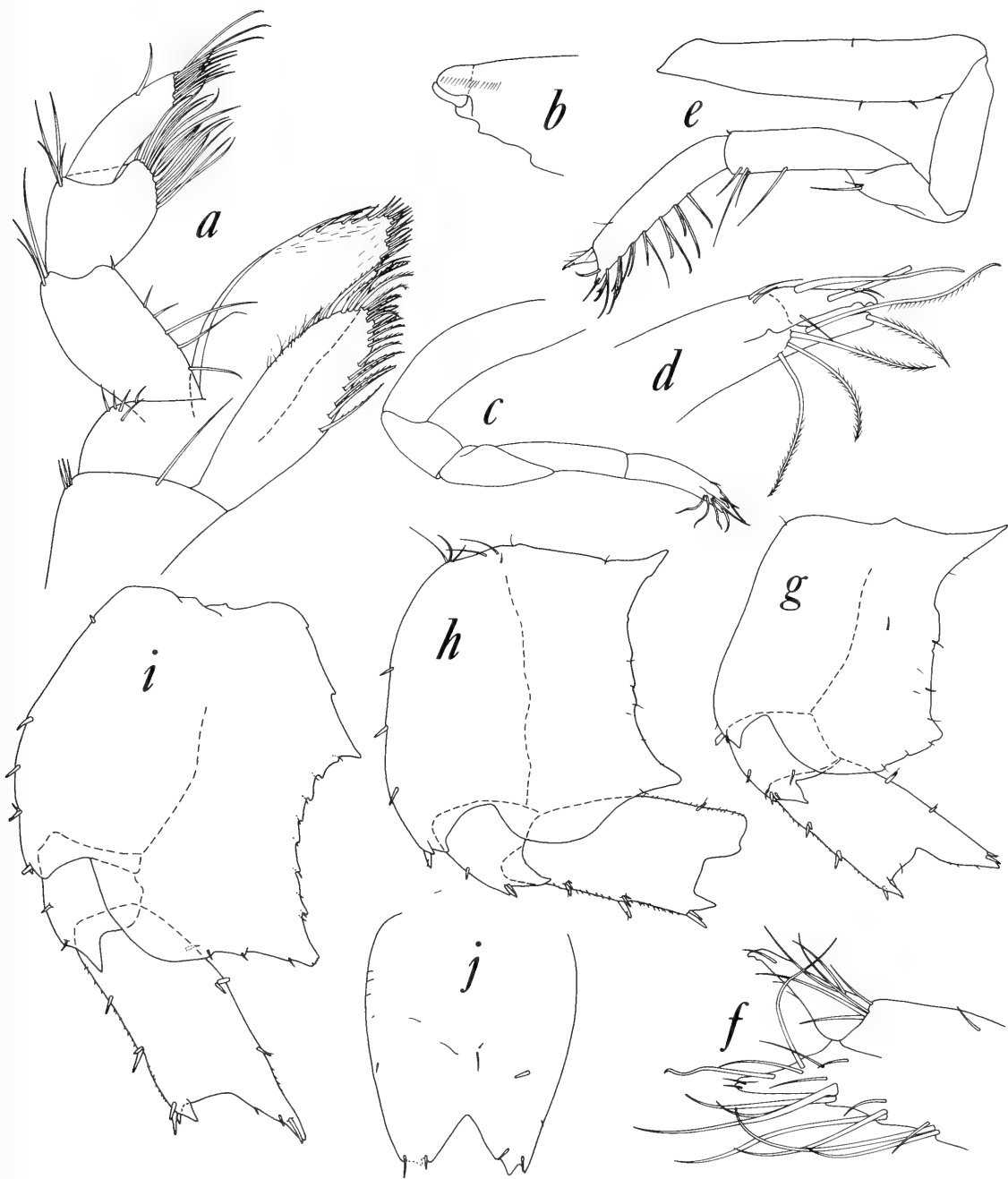


Fig. 13. *Iphimediella acuticoxa*, juvenile: **a**, Maxilliped; **b**, Maxilliped distal end of article 3 and minute article 4, seta omitted; **c**, Gnathopod 1; **d**, Gnathopod 1 propodus fixed finger and dactyl; **e**, Gnathopod 2; **f**, Gnathopod 2 propodus fixed finger and dactyl; **g**, Pereopod 5; **h**, Pereopod 6; **i**, Pereopod 7; **j**, Telson.

*Iphimediella bransfieldi* Barnard 1932

Figs. 14, 15

*Iphimediella bransfieldi* Barnard, 1932:119 (part).—Nicholls, 1938:70, fig. 37J.

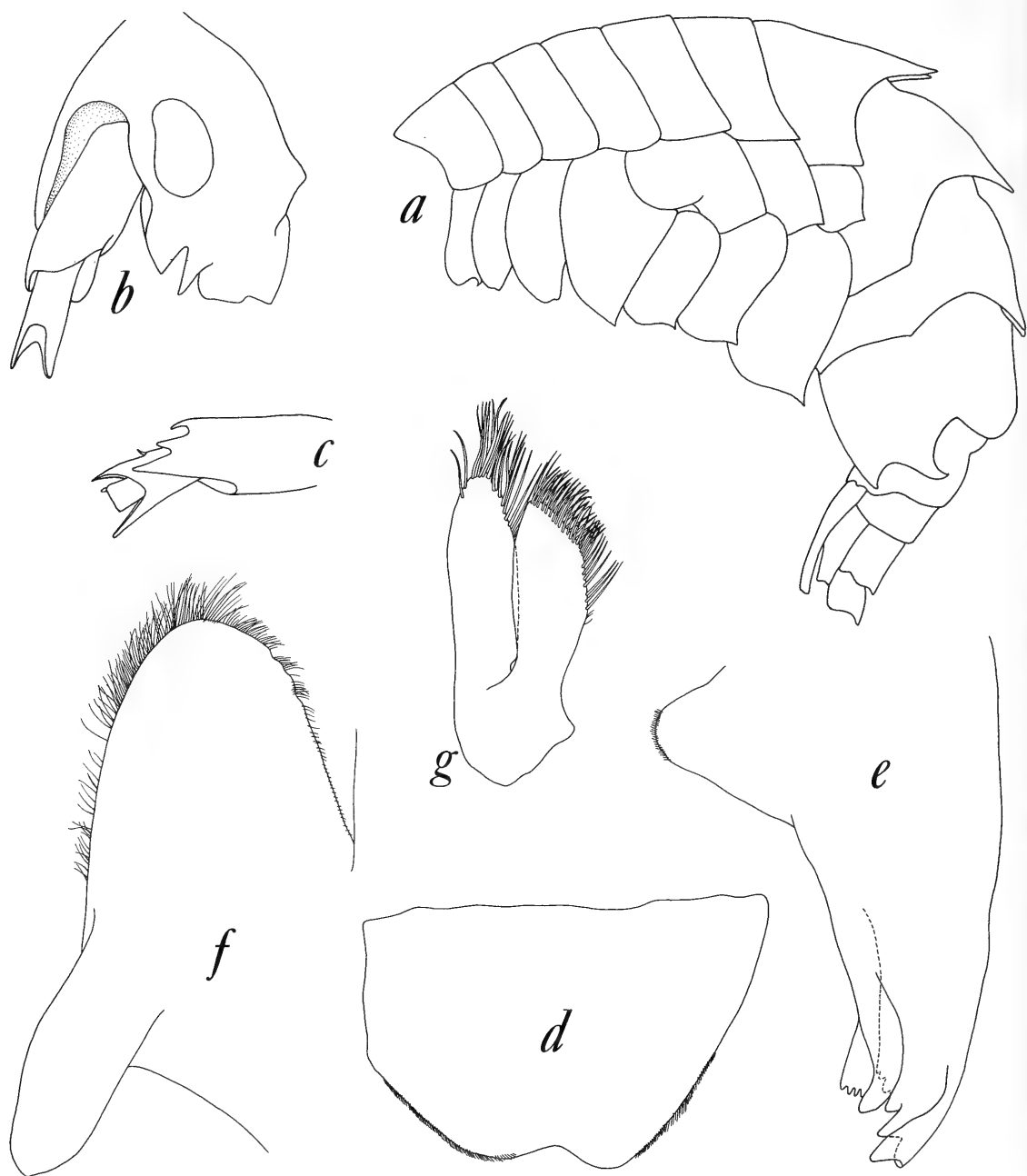


Fig. 14. *Iphimediella bransfieldi*, female: a, Body, side view; b, Head; c, Antenna 1 peduncle and uniarticulate accessory flagellum; d, Upper lip; e, Mandible; f, Lower lip; g, Maxilla 2.

**Material.**—*Discovery* Sta. 175, 2 Mar. 1927, 63°17'S, 59°48'W, 200 m (BMNH No. 1936. 11. 2. 1080–1081) 1 ♀ ovigerous, 22 mm (lectotype). *Eltanin* Cruise 51, Sta. 5761, 8 Feb. 1972, 76°01.6'S, 179°49.9'E, 388–399 m, 1 ♀, with eggs, 22 mm.

**Diagnosis.**—Body with short, paired dorsal processes on pereonite 7 and pleonites 1 and 2; antenna 1 peduncle article 2, ventrodiscal tooth longer

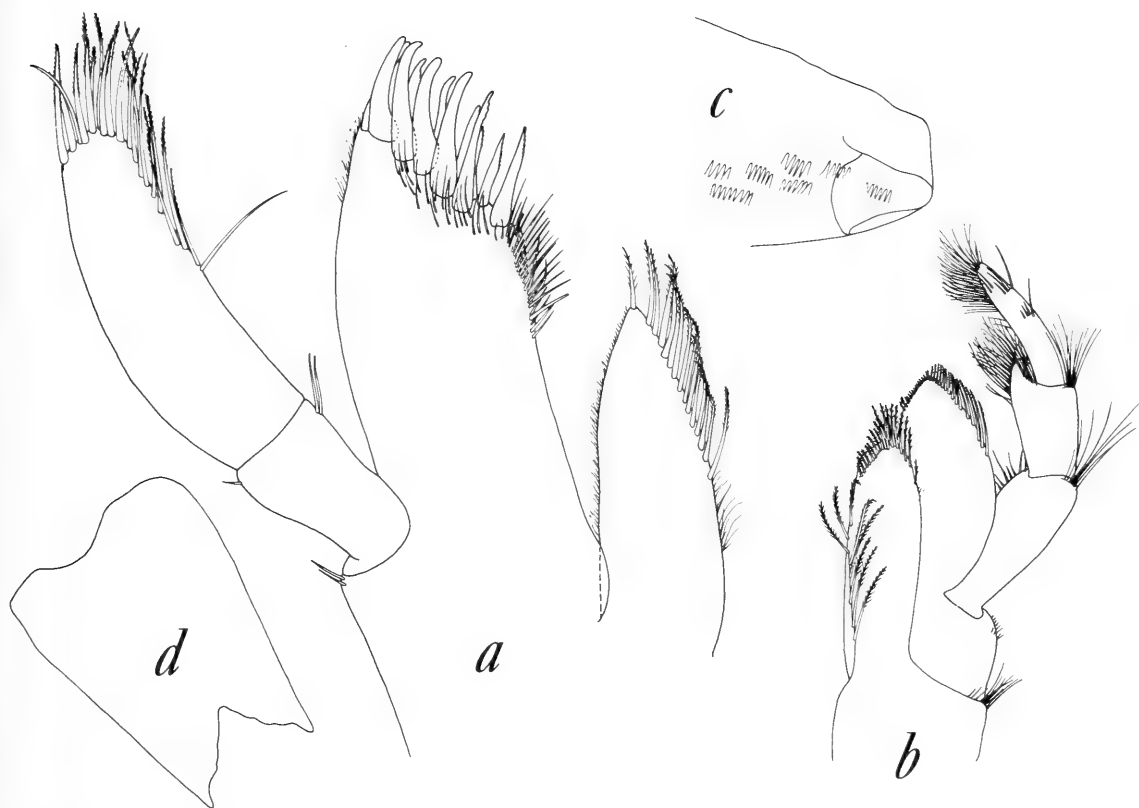


Fig. 15. *Iphimediella bransfieldi*, female: a, Maxilla 1; b, Maxilliped; c, Maxilliped distal end of article 3 and minute article 4, seta omitted; d, Telson.

than dorsal tooth; coxae 1–4 anteroventral margins smooth; upper lip emarginate.

**Description.**—The following supplements the description given by Barnard (1932). Body with short, wide dorsal processes on pereonite 7 and pleonites 1 and 2, each pair forms distinct “V” dorsally; urosomite 1 without mid-dorsal carina. Head anterolateral margin with narrow sinus bounded below by short tooth; rostrum shorter than antenna 1 first peduncle article. Coxa 1 anteroventral corner broadly rounded.

Antenna 1 peduncle short, ventrodistal tooth on first article with 2 short accessory teeth; peduncle article 2, ventral tooth longer than dorsal; accessory flagellum uniarticulate. Upper lip slightly incised, ventrolateral margins with dense covering of short hairs. Right mandible incisor and accessory plate multidentate; molar conical, strong, with apical tuft of short hairs. Lower lip apically narrow, without inner lobes. Maxilla 1 palp article 2 elongate, armed along distal half of inner margin; outer plate subrectangular, distal edge with strong spines, medial edge setose distally; inner plate subacute, distal half of medial margin with short plumose setae. Maxilla 2 inner and outer plates longer than wide. Maxilliped outer plate subovate, unarmed along proximal half of lateral margin; palp with 4 articles, the last minute,

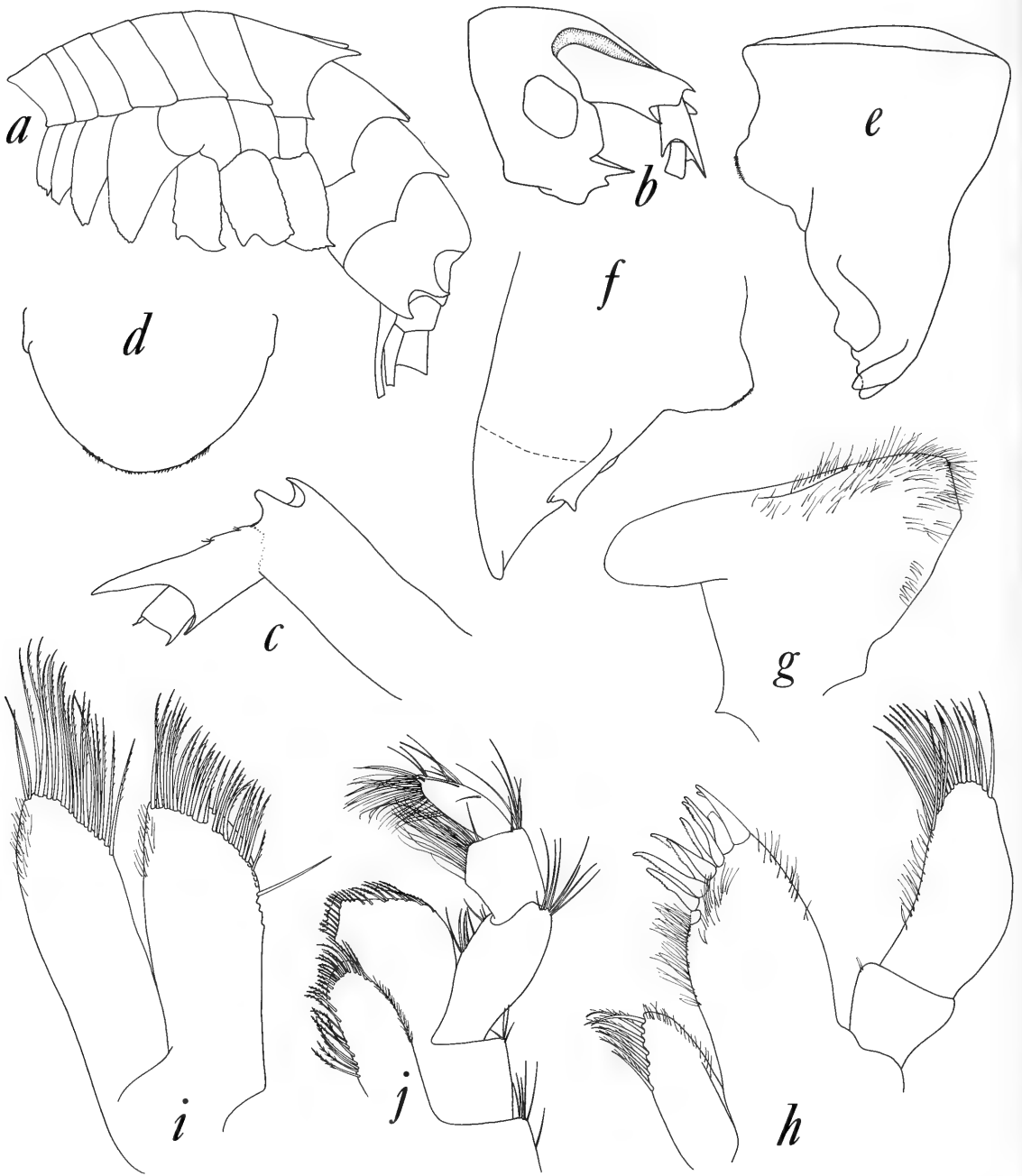


Fig. 16. *Iphimediella discoveryi*, female: a, Body, side view; b, Head; c, Antenna 1 peduncle articles and accessory flagellum; d, Upper lip; e, Right mandible; f, Left mandible; g, Lower lip; h, Maxilla 1; i, Maxilla 2; j, Maxilliped.

detectable only at high magnification, partly covered by hoodlike extension of article 3; palp article 3 longer than article 2, subequal in length to article 1. Telson with broad V-shaped cleft, apices acute.

*Distribution*.—South Shetland Islands, approximately 200 m.

*Remarks*.—K. H. Barnard (1932) briefly described, but did not illustrate,



Fig. 17. *Iphimediella discoveryi*, female: a, Gnathopod 1; b, Gnathopod 2; c, Pereopod 5; d, Telson distal margin.

this species from 2 ovigerous syntypes collected off the South Shetland Islands. In his description he noted that the smaller of the 2 specimens differed somewhat from the larger. We have examined both specimens and found them to differ considerably, especially in their mouthpart morphology. Since the smaller of the 2 specimens seemed to represent to K. H. Barnard exceptions to the typical *I. bransfieldi*, we have chosen it as the holotype of a new species, *I. discoveryi*, which is described below. The larger specimen becomes the lectotype of *I. bransfieldi*.

*Iphimediella discoveryi* n. sp.

Figs. 16, 17

*Iphimediella bransfieldi* Barnard, 1932:119 (part).

**Material.**—Holotype: *Discovery* Sta., 175, 2 Mar. 1927, 63°17'S, 59°48'W, 200 m (BMNH No. 1936. 11. 2. 1080–1081), 1 ♀ ovigerous, 14 mm. Paratype: *Eltanin* Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41'S, 54°43'W, 210–220 m, 1 juvenile.

**Diagnosis.**—Body with short, paired dorsal processes on pereonite 7 and pleonites 1 and 2 meeting to form “V” dorsally; antenna 1 peduncle article 2 dorsodistal tooth longer than ventral; coxae 1–4 anteroventral margins and pereopods 5–7 basis hind margin serrate; upper lip entire.

*Description*.—Body with short, paired dorsal processes on pereonite 7 and pleonites 1 and 2; processes meet mid-dorsally to form a “V”; urosomite 1 without mid-dorsal carina. Head anterolateral margin with shallow sinus bounded below by long, acute tooth. Coxa 1 tapering, anteroventral corner not rounded, ventral margin slightly concave, serrate.

Antenna 1 peduncle article 2 with dorsal tooth longer than ventral. Upper lip broadly rounded with setae along ventral margin. Mandible stout relative to *I. bransfieldi*; molar a slight, setose protuberance; accessory plate on left mandible toothed, on right mandible smooth. Lower lip apically truncate, without inner lobes. Maxilla 1 palp article 2 armed with hairlike setae along most of inner margin; outer and inner plates similar to *I. bransfieldi*. Maxilliped palp with minute article 4; palp article 2 nearly as wide as long; article 3 longer than article 2, article 1 longer than article 3; outer plate as broad as long, distal margin with elongate plumose setae. Pereopod 5 basis anterior and posterior margins parallel, posterior and ventral margins serrate. Telson shallowly cleft, apices rounded.

*Etymology*.—The species is named in honor of the R.R.S. *Discovery*.

*Distribution*.—Antarctic Peninsula, 200–220 m.

*Remarks*.—The form and number of paired dorsal processes on the body gives this species the appearance of *I. bransfieldi*. The following features, however, readily distinguish the two: 1) coxal plates 1–4 anteroventral margins and pereopod 5–7 basis hind margins serrate in *I. discoveryi* and smooth in *I. bransfieldi*; 2) pereopod 5 basis much less expanded in *I. discoveryi* than in *I. bransfieldi*; 3) antenna 1 peduncle article 2 dorsal tooth longer than ventral in *I. discoveryi* whereas the reverse is the case in *I. bransfieldi*; 4) upper lip ventral margin entire in *I. discoveryi* and emarginate in *I. bransfieldi*; 5) telson apices rounded in *I. discoveryi* and subacute in *I. bransfieldi*.

*Iphimediella cyclogena* Barnard 1930

Figs. 18, 19

*Iphimediella cyclogena* Barnard, 1930:349, fig. 23.

*Iphimediella intermedia* Nicholls, 1938:71, fig. 37 (new synonymy).

*Material*.—*Eltanin* Cruise 12, Sta. 1002, 15 Mar. 1964, 62°40'S, 54°44'–45'W, 265 m, 1 ♀; *Eltanin* Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41'S, 54°43'W, 210–220 m, 3 ♂♂. *Terra Nova* Sta. 4 (194?) (BMNH No. 1930.8.1: 180–182) (Oates Land?).

*Diagnosis*.—Body with 4 pairs elongate, smooth dorsal processes; coxa 1 anteroventral corner narrowly rounded, ventral margin concave; coxae 2 and 3 tapering distally, posteroventral corner produced ventrally; antenna 1 peduncle article 1 ventrodorsal tooth extends beyond distal margin of peduncle article 2; head lateral margin with narrow notch bounded above by sharp point and below by blunt lobe.

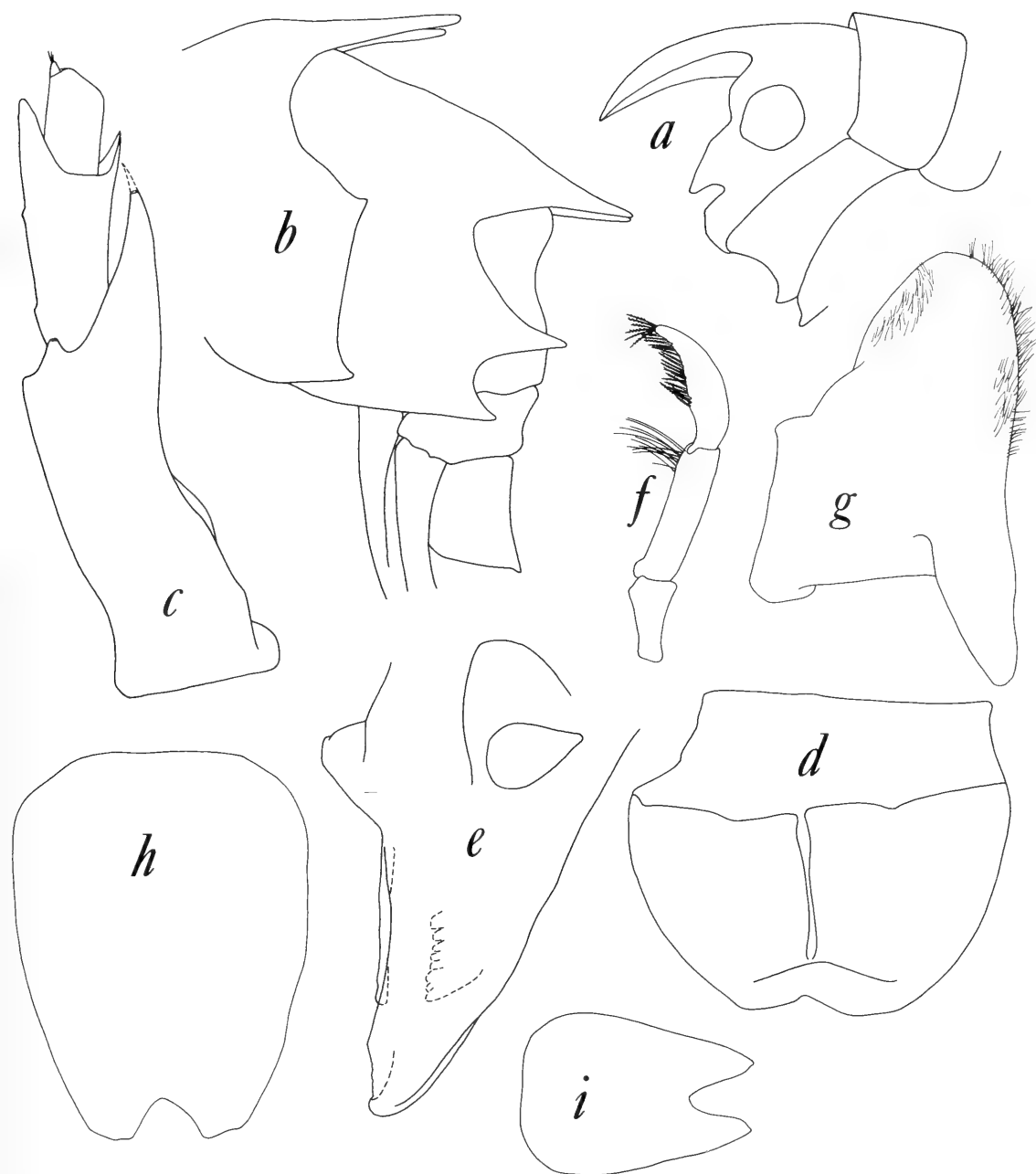


Fig. 18. *Iphimediella cyclogena*, Terra Nova specimen, male: a, Head and coxa 1; b, Pleonites 2, 3 and urosome; c, Antenna 1 peduncle and accessory flagellum; d, Upper lip; e, Mandible; f, Mandible palp; g, Lower lip; h, Telson. Male, *Eltanin* Sta. 1003; i, Telson.

**Description.**—The following supplements the description given by K. H. Barnard (1930). Antenna 1 with minute accessory flagellum. Upper lip slightly incised. Mandible molar with small apical tuft of short hairs. Lower lip without inner lobes. Maxillae 1 and 2 similar to *I. bransfieldi*. Maxilliped palp article 4 minute, as wide as high, covered by hoodlike extension of article 3; article 2 shorter than articles 1 and 3, only slightly produced me-





Fig. 19. *Iphimediella cyclogena*, Terra Nova specimen, male: a, Maxilla 1; b, Maxilla 2; c, Maxilliped; d, Gnathopod 1; e, Gnathopod 1 propodus fixed finger and dactyl; f, Gnathopod 2; g, Gnathopod 2 propodus and dactyl, setae omitted.

dially. Gnathopod 1 chelate, sparsely setose; dactyl overhangs fixed finger of propodus. Gnathopod 2 chelate, setose along ventral margin of articles 4, 5 and 6; dactyl shorter than fixed finger of propodus. Telson shallowly cleft.

*Distribution*.—Shelf off tip of Antarctic Peninsula, Oates Land, Ross Sea, Adelie Coast, 329–540 m.

*Remarks.*—We compared the illustrations of *I. cyclogena* given by K. H. Barnard (1930:350) with specimens borrowed from the British Museum and found the following variations: 1) coxa 1 as illustrated appeared to be sharply angled at the anteroventral corner, however, all specimens we examined had a rounded anteroventral corner; 2) the length of the dorsal processes on pleonite 3 were proportionately longer and slightly upturned in smaller versus larger specimens; 3) the head lateral margin as illustrated appeared to be very diagrammatic since the lobe below the sinus is actually much less rounded; 4) the shape of the telson differed from specimen to specimen. Nicholls (1938:73) distinguished *I. intermedia* from *I. cyclogena* using “the shape of the head, of the first coxal plate, outline of peraeon segment 7 and pleon segments 1–3, in proportions and other details of peduncular joints of first and second antennae and the presence of secondary cutting plates on both mandibles.” For all specimens of *I. cyclogena* we examined, the above characters had to be rejected either on the basis of overall variability or because of incorrect interpretation of the illustrations. Thus we conclude that *I. intermedia* is a synonym of *I. cyclogena*.

### *Pseudiphimediella* Schellenberg

*Pseudiphimediella* Schellenberg, 1931:119.

*Pariphimediella* Schellenberg, 1931:121 (part) (new synonymy).

*Type-species.*—*Amphitoe nodosa* Dana, 1853 (original designation).

*Diagnosis.*—Upper lip incised or sinuous; epistome not more than 3 times as wide as high; mandible incisor broad, thin-edged, multi-toothed, and curved toward midline so as to cut in the frontal plane; maxilliped palp article 2 broadened, not produced, outer plate broad.

*Remarks.*—Schellenberg (1931) distinguished *Pseudiphimediella* from *Pariphimediella* on the basis of the former possessing a deeply incised upper lip and broadened articles 1 and 2 on the maxilliped palp. As discussed under the remarks for *Iphimediella*, Schellenberg's *P. glabra* differs from other *Iphimediella* species (*sensu* Karaman and J. L. Barnard, 1979) but is similar to *Pseudiphimediella nodosa* in possessing mouthparts with a broadened aspect and, more significantly, in the orientation of the mandible incisor which cuts in the frontal plane. The genus *Pseudiphimediella* as presently defined thus contains the 2 species *P. nodosa* (Dana) and *P. glabra* (Schellenberg).

*Pseudiphimediella glabra* (Schellenberg, 1931) new combination

Fig. 20

*Pariphimediella glabra* Schellenberg, 1931:121, fig. 65; pl. 1, fig. B.

*Material.*—Eltanin Cruise 9, Sta. 740, 18 Sept. 1963, 56°06–07'S, 66°19–

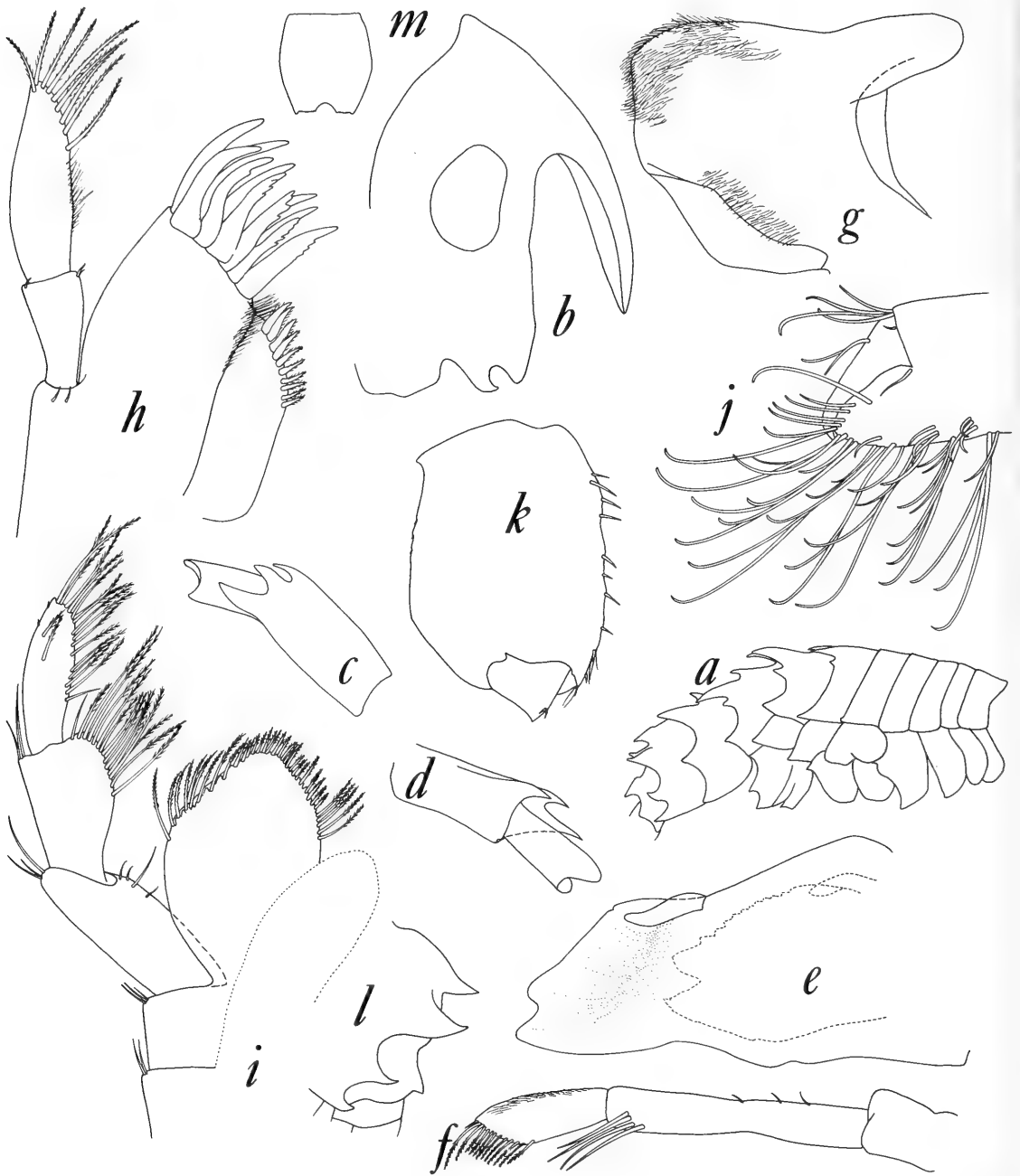


Fig. 20. *Pseudiphimediella glabra*, female: a, Body, side view; b, Head; c, Antenna 1 peduncle ventral view; d, Antenna 1 peduncle dorsal view; e, Mandible; f, Mandible palp; g, Lower lip; h, Maxilla 1; i, Maxilliped; j, Gnathopod 2 propodus fixed finger and dactyl; k, Pereopod 6; l, Pleonite 3 and urosomites 1 and 2; m, Telson.

30'W, 384–494 m, 1 ♀ with eggs, 2 ♂♂; *Eltanin* Cruise 11, Sta. 977, 13 Feb. 1964, 52°32'S, 63°53'W, 229 m, 1 ♀ with eggs, 2 ♂♂, 1 juvenile.

*Diagnosis*.—Body with paired dorsal processes on pereonites 6 and 7 and pleonites 1–3; urosomite 1 with strong mid-dorsal keel; maxilla 1 inner plate with 9–10 stout plumose setae; maxilliped inner plate medial margin armed with several setae.

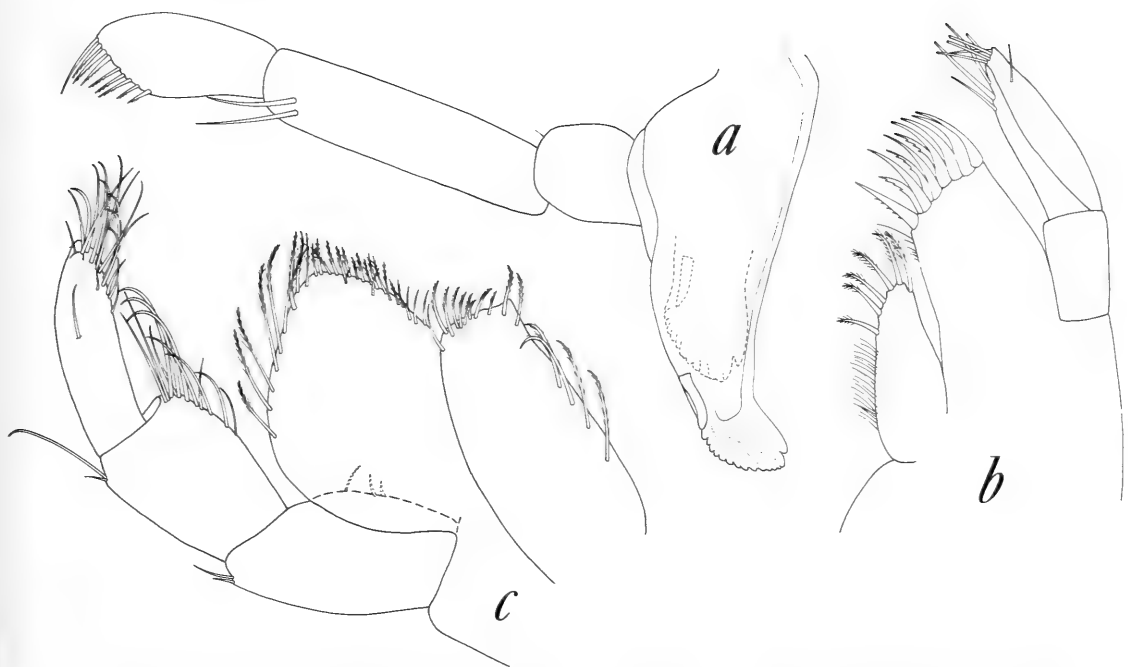


Fig. 21. *Pseudiphimediella nodosa*, female: a, Mandible; b, Maxilla 1; c, Maxilliped.

*Description.*—The following supplements the description given by Schellenberg (1931). Antenna 1 peduncle article 1 with 3 teeth along distal margin, 2 ventral and 1 lateral. Mandible shortened, with broad, thick incisor; accessory plate with elongate cutting edge; palp article 3 half length of article 2, armed along distal half of ventral margin. Lower lip distal apex broadened, sinuous. Maxilla 1 palp biarticulate, reaching beyond distal half of medial margin; outer plate subrectangular; inner plate armed with short, stout plumose setae. Maxilliped palp 4-articulate, article 3 apex extended slightly covering minute fourth article (seen using SEM); article 2 expanded medially but only slightly along article 3, outer plate broadly ovate, armed with stout plumose setae. Gnathopods 1 and 2 chelate; fixed finger of gnathopod 2 propodus much wider than dactyl, heavily armed with setae.

*Distribution.*—Burdwood Bank, Falkland Islands and Magellanic area, 2–494 m.

*Remarks.*—The specimens examined by us differed from the illustrations of Schellenberg (1931) in the following features: mid-dorsal keel on urosomite 1 varied considerably in size; pereopod 6 basis hind margin lower corner was without a tooth; coxa 1 was more rounded distally.

*Pseudiphimediella nodosa* (Dana, 1853)  
Fig. 21

*Iphimedia nodosa* Dana, 1853–55:928, pl. 63, figs. 3A, B.  
*Pseudiphimediella nodosa*: Schellenberg, 1931:119, fig. 64, pl. 1, fig. A.  
*Iphimediella nodosa*: K. H. Barnard, 1932:119, fig. 67.

*Material*.—William Scoresby Sta. 85, 25 March 1927, 8 mi. S, 66°E of Lively Island, East Falkland Island, 79 m, 1 ♀ with young (BMNH 1936. 11. 2. 1082).

*Diagnosis*.—Body with paired dorsal processes on pereonite 7 and pleonites 1–3; urosomite 1 with mid-dorsal keel; maxilla 1 inner plate with few, elongate plumose setae; maxilliped inner plate medial margin unarmed.

*Description*.—The following supplements the descriptions given by Schellenberg (1931) and K. H. Barnard (1932). Right mandible with small accessory plate; incisor spoon-shaped, multitoothed; mandible oriented such that incisors move in frontal plane; palp article 2 elongate, with 2 setae on distal corner. Maxilla 1 inner plate weakly armed; palp article 2 broad. Maxilliped palp article 4 minute, covered by hoodlike extension of article 3; palp article 2 broadened, not produced; inner plate medial margin weakly armed.

*Distribution*.—Falkland Islands, Magellanic region; low tide to 150 m.

*Remarks*.—The illustrations given by Schellenberg (1931) for this species are extremely diagrammatic and do not contain the information critical for evaluating its relationships. On examination of British Museum material we found that the maxilliped palp articles 1 and 2 were not appreciably broadened compared to some species of *Iphimediella* and *Gnathiphimedia*. *P. nodosa* was, however, very distinct in the shape and orientation of the mandible. We have looked at mandible orientation in several genera of Acanthonotozomatidae and conclude that several generic complexes can be discerned using this feature. The mandible incisors of *Pseudiphimediella* and *Maxilliphimedia* are oriented such that they meet and thus cut or pinch along the frontal plane of the head, which is the condition typical of most gammaridean anphipods. *Gnathiphimedia*, *Iphimediella* and most species of *Iphimedia* have mandible incisors that are oriented to cut along the transverse plane of the head. It is this orientation which has led to the description of acanthonotozomatid mouthparts as being arranged in a “conical bundle.” Within the transversely biting mandible group there is some variation in the form of the incisor, for example, in *Gnathiphimedia* the thickened, smoothly rounded incisor edge apparently functions in a “crushing” mode while the blade-like incisor of *Iphimediella* probably functions in a cutting mode.

### Paramphithoidae

#### *Epimeria* Costa

*Epimeria* Costa in Hope, 1851:46.

*Pseudepimeria* Chevreux, 1911:1167 (new synonymy).

*Subepimeria* Bellan-Santini, 1972:225.

*Type-species*.—*Gammarus corniger* J. C. Fabricius 1779.

*Diagnosis* (emended from J. L. Barnard, 1969).—Rudimentary accessory flagellum; mandible molar large, ridged; lower lip lacking inner lobes; max-

illiped palp 4-articulate; gnathopods simple or subchelate, dactyls often spinose, much shorter than propodus; coxae 4–5 together forming a more or less crescentic curve below.

*Remarks.*—As pointed out by Karaman and Barnard (1979) the characters used by Bellan-Santini (1972) to establish the genus *Subepimeria* (presence of uniarticulate accessory flagellum, simple gnathopods) were not distinctive at the generic level. All species of *Epimeria* examined in this study have been found to have an uniarticulate accessory flagellum. Karaman and Barnard (1979) also suggested that *E. geodesiae* (Bellan-Santini) showed very weak gnathopodal palms and thus were not, in fact, simple. Weak palms are also found in *E. puncticulata* K. H. Barnard. These latter species intergrade to the true simple gnathopod seen in *Pseudepimeria* Chevreux, leaving no characters by which *Pseudepimeria* and *Epimeria* can be distinguished.

*Epimeria rimicarinata* n. sp.

Figs. 22, 23

*Material.*—Holotype, *Eltanin* Cruise 27, Sta. 1875, 15 Jan. 1967, 72°32'S, 171°26–28'E, 337–329 m, 1 non-ovigerous ♀, 35 mm (USNM 173590); paratype, Cruise 32, Sta. 2080, 31 Jan. 1968, 75°50–52'S, 173°08'W, 468–474 m, 1 ♂, 35 mm (USNM 173591).

*Diagnosis.*—Body with mid-dorsal carinae on pereonites 3–7, pleonites 1–3 and urosomites 1 and 2, those on pereonites 5–7, pleonites 1–3 and urosomite 1 distinctly cleft into anterior and posterior teeth; pereonites 5–7, pleonites 1–3 and urosomite 1 with dorsolateral carinae; coxa 4 broadly quadrate ventrally, posteroventral corner slightly produced; coxa 5 posteroventral corner slightly, bluntly produced.

*Description.*—Body bluntly processiferous. Mid-dorsal carinae on pereonites 3–7, pleonites 1–3 and urosomites 1 and 2, those on pereonites 5–7, pleonites 1–3 and urosomite 1 distinctly cleft into 2 consecutive posteriorly-directed teeth. Pereonites 5–7, pleonites 1–3 and urosomite 1 with small dorsolateral carinae. Pleonites 1–3 and urosomite 1 each bear one additional lateral protuberance anteriorly. Coxae 1–3 narrowly subrectangular with anteroventral corners rounded, posteroventral corners angular. Coxa 4 ventral margin broadly quadrate, posteroventral corner slightly produced. Coxa 5 posteroventral margin bluntly produced. Rostrum long, strongly curved ventrally, extending beyond antenna 1 peduncle article 1. Antenna 1 shorter than antenna 2 in both sexes, with uniarticulate accessory flagellum; peduncle article 1 twice length article 2, with several small teeth on mediodistal margin. Upper lip incised, lobe apices setose. Mandible molar large, crushing ("tritulative"); incisor multidentate; left lacinia mobilis multidentate, right lacinia mobilis bidentate; palp articles 2 and 3 subequal, heavily setose. Lower lip entire, without inner lobes. Maxilla 1 inner plate subtriangular with 9 apical plumose setae; outer plate with 14 slender spines on distal

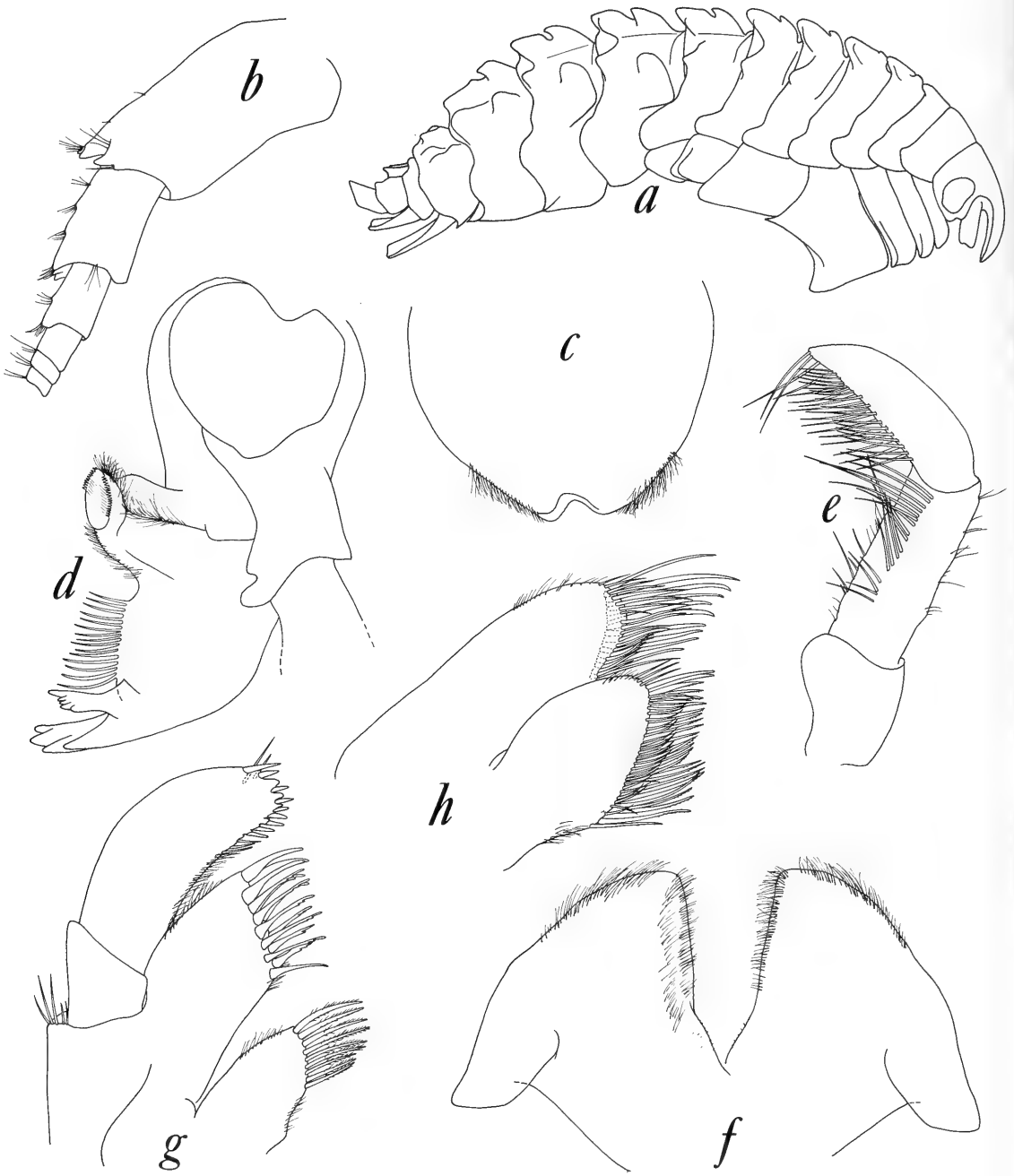


Fig. 22. *Epimeria rimicarinata*, female: a, Body, side view; b, Antenna 1; c, Upper lip; d, Mandible; e, Mandible palp; f, Lower lip; g, Maxilla 1; h, Maxilla 2.

margin; palp article 2 distally armed with short, stubby spines extending proximally along  $\frac{1}{3}$  inner margin, grading into fine setae. Maxilla 2 inner and outer plates approximately equal in width, heavily setose along distal margins. Maxilliped inner plate with plumose setae along medial and distal margins; outer plate with nonplumose setae distally, short submarginal spines medially; palp 4-articulate, article 2 longest; palp article 4 with 8 slender spines on inner margin. Gnathopods subchelate, similar, gnathopod

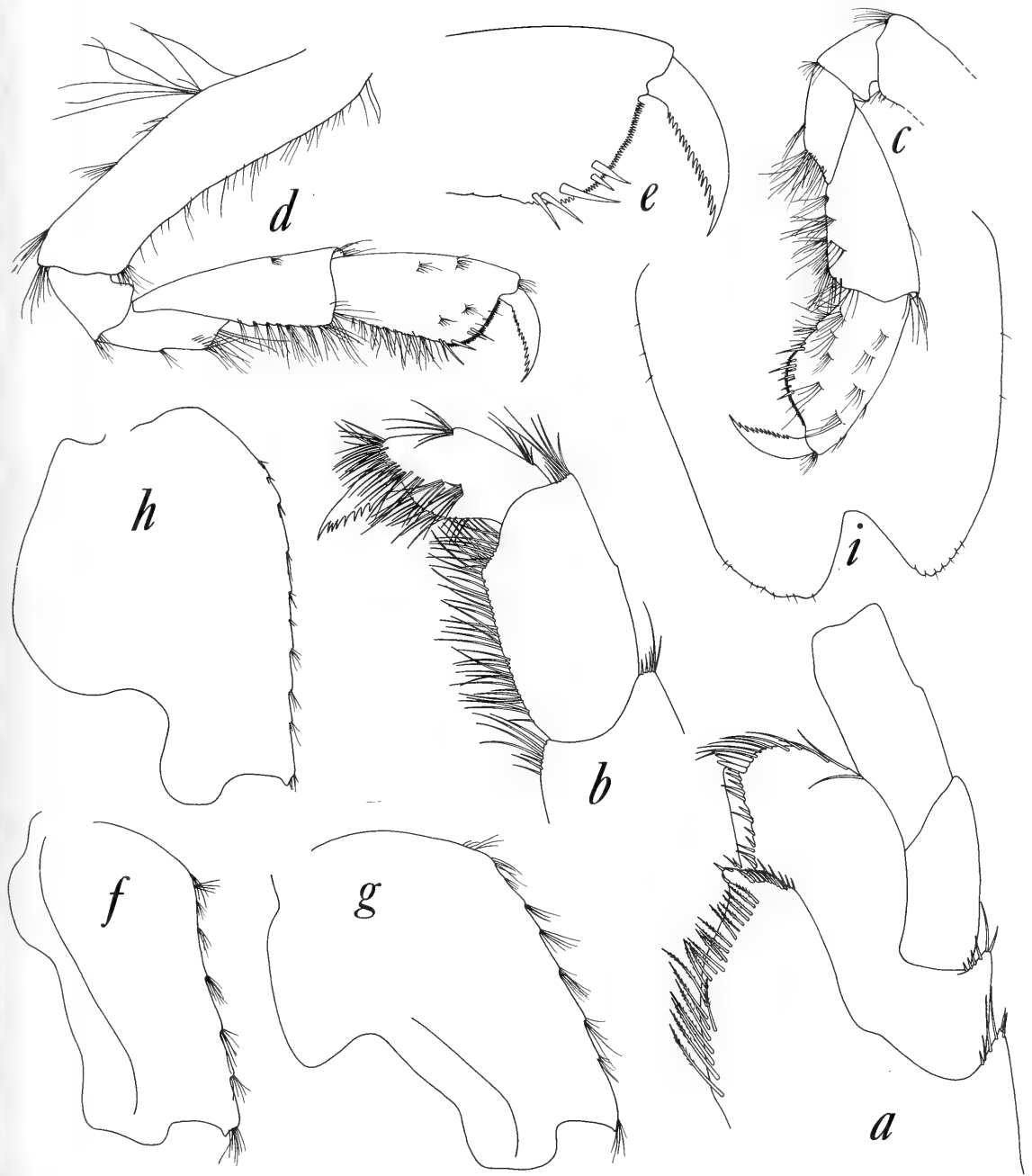


Fig. 23. *Epimeria rimicarinata*, female: a, Maxilliped, without palp; b, Maxilliped palp; c, Gnathopod 1; d, Gnathopod 2; e, Gnathopod 2 propodus and dactyl; f, Pereopod 5; g, Pereopod 6; h, Pereopod 7; i, Telson.

1 slightly smaller than gnathopod 2, articles 5 longer than articles 6; dactyls with numerous spines on inner margin. Pereopod 5 basis with small proximal lobe on posterior margin, distal  $\frac{2}{3}$  posterior margin parallel to anterior margin. Pereopods 6 and 7 proximal lobes of basis posterior margins successively enlarged, producing incised appearance. Telson cleft  $\frac{1}{4}$ , setae on apices.





*Parepimeria bidentata* Schellenberg

Fig. 24

*Parepimeria bidentata* Schellenberg, 1931:164.*Parepimeria crenulata* K. H. Barnard, 1932:179 (part).

*Material*.—*Eltanin* Cruise 12, Sta. 1003, 15 Mar. 1964, 62°41'S, 54°43'W, 210–220 m, 5 spec.; *Discovery* Sta. 42, 1 April 1926, off mouth of Cumberland Bay, South Georgia, 120–204 m, 1 ♂, 12 ♀♀; *Isla Orcadas* Cruise 19, Sta. 27, 29 Mar. 1979, 53°57'S, 36°08'W, 180 m, 1 ♀ with eggs.

*Diagnosis*.—Rostrum long, extending horizontally outward from head; body with paired dorsolateral processes on pereonites 3 to 7; pleonites 1 and 2 with backwardly-directed mid-dorsal carinae; pleonite 3 with acute mid-dorsal tooth; epimeral plate 3 posterior margin serrate; maxilliped palp article 4 strong; gnathopods 1 and 2 dactyl shorter than propodus.

*Description*.—Body with paired sub-dorsal carinae on pereonites 3–7, increasing in length posteriorly; pleural tubercles pronounced on pereonites 4–6; pleonites 1–3 with mid-dorsal carinae, the first two posteriorly-directed, the last recurved anteriorly; posterior margin of epimeral plates 2 and 3 strongly serrate; coxa 1 anteroventral corner subacutely produced anteriorly, posteroventral corner rounded, ventral margin slightly serrate; coxa 3 anteroventral corner bluntly produced downward; coxa 4 narrowly rounded distally. Rostrum long, extending beyond distal end of antenna 1 peduncle article 1, often beyond distal end of peduncle article 2; head angle subacute; eyes large, protruding from side of head. Antenna 1 with uniarticulate accessory flagellum; peduncle articles 1–3 subequal in length; peduncle and flagellar articles bear ventrally-directed long, thin setae. Antenna 2 longer than antenna 1; peduncle article 5 slightly longer than article 4. Mandible with strong, triturative molar; left lacinia mobilis with approximately 4 teeth, right lacinia mobilis bifid; palp articles 2 and 3 elongate, approximately 5 times as long as wide; both articles armed ventrally throughout their length with long stiff setae. Maxilla 1 palp with subapical group of setae; inner plate with 3 terminal setae, outer plate with 7. Maxilla 2 inner and outer plates terminally rounded, outer plate without setae along medial margin. Maxilliped with 4-articulate palp; palp terminal article slender, spinelike, three-fourths length of article 3; article 3 with dense terminal cluster of setae; outer plate reaches less than half length of palp article 2, not falciform; inner plate short, reaching only to end of first palp article.

Gnathopod 1 simple; dactyl greater than half length of article 6, slender, spiniform; articles 5 and 6 subequal in length; article 5 proximally expanded, with 2 rows of ventrally-directed, long, stiff setae, one medial, the other along ventral margin. Gnathopod 2 similar to gnathopod 1, but articles 5 and 6 more elongate. Pereopods 5 and 6 basis subrectangular, posteroventral

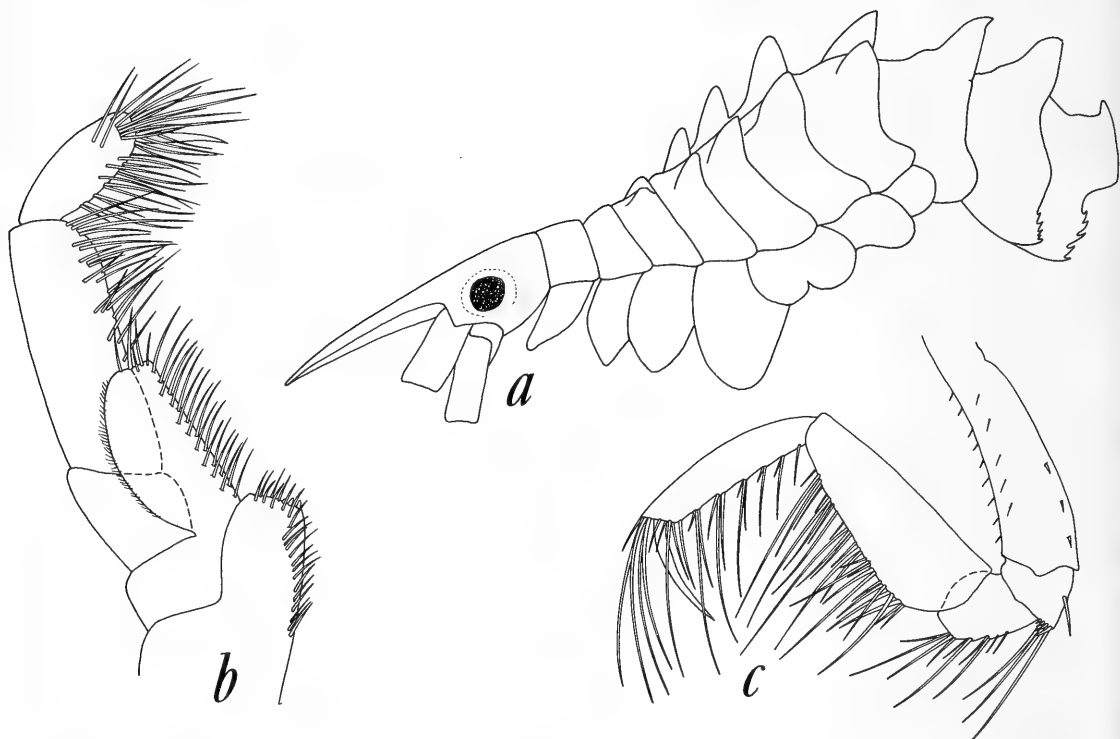


Fig. 24. *Parepimeria bidentata*, female: a, Body, side view; b, Maxilliped; c, Gnathopod 1.

corner extended as a lobe. Pereopod 7 basis tapers distally. Uropods 1–3, outer ramus shorter than inner. Telson entire, broadly rounded.

*Distribution*.—Shelf off Joinville Island (Antarctic Peninsula), Shag Rocks, South Georgia.

*Remarks*.—In most details, especially with respect to the mouthparts, *P. bidentata* and *P. crenulata* are very similar. Chevreux (1912) did not record an article 4 on the maxilliped palp but since it is difficult to see in other species, it is likely that it escaped Chevreux's notice. The major difference between *P. bidentata* and *P. crenulata* then, becomes the presence of a mid-dorsal carina on pereonites 2–7 in *P. crenulata* which is lacking in *P. bidentata*. We re-examined the specimens from *Discovery* Station 42 (Barnard 1932) and found them to correspond to the description of *P. bidentata* rather than *P. crenulata* as determined by K. H. Barnard. It is not known whether the remainder of the material examined by K. H. Barnard also is *P. bidentata*.

*Parepimeria minor* n. sp.

Fig. 25

*Material*.—*Eltanin* Cruise 6, Sta. 410, 31 Dec. 1962, 61°18–20'S, 56°09–10'W, 220–240 m, 3 spec., 5.0 mm holotype (USNM 173592); 4.0 mm and 2.0 mm paratypes (USNM 173593).

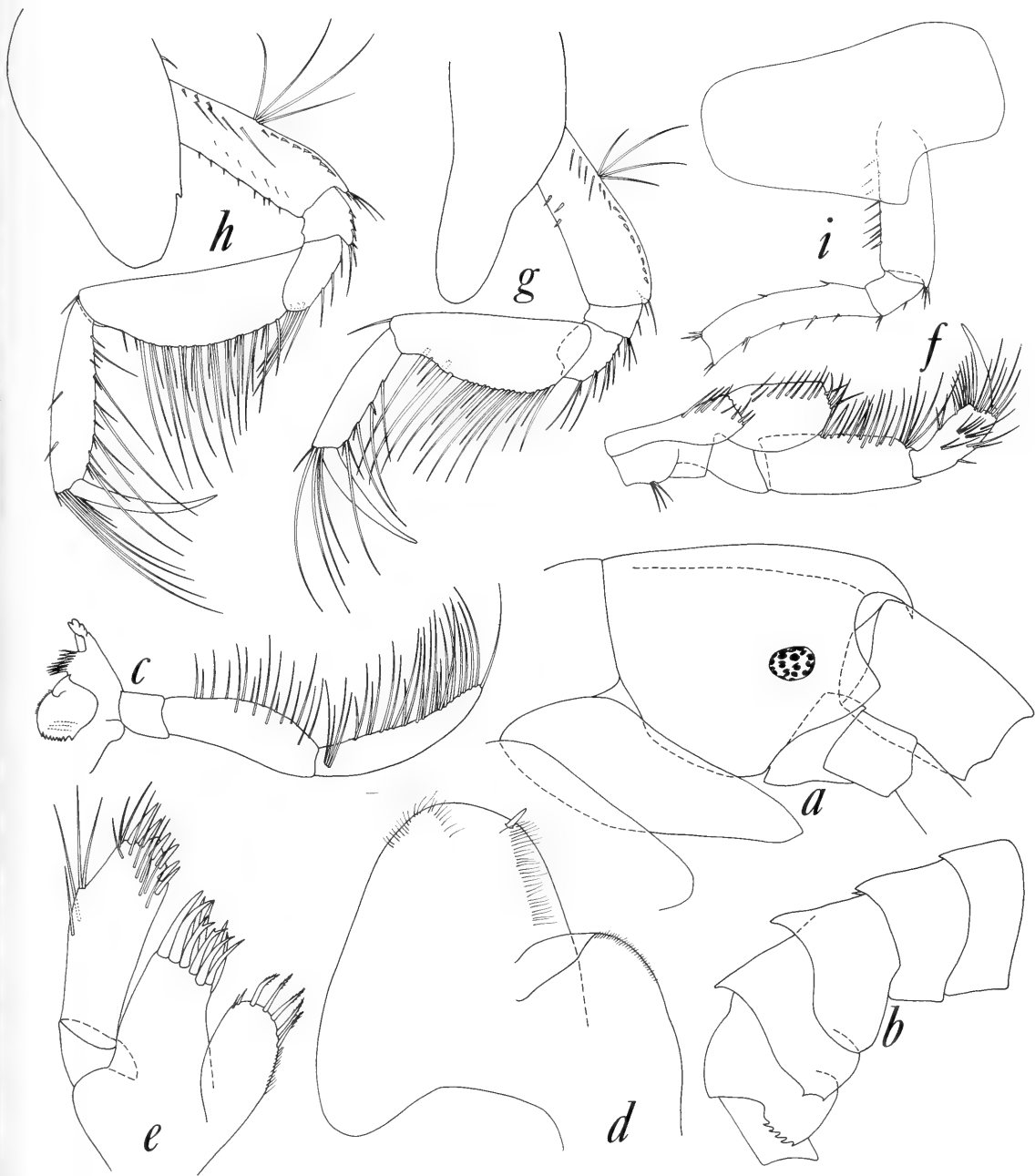


Fig. 25. *Parepimeria minor*, female: a, Head and pereonite 1; b, Pereonites 6 and 7 and pleonites 1-3; c, Mandible; d, Lower lip; e, Maxilla 1; f, Maxilliped; g, Gnathopod 1; h, Gnathopod 2; i, Pereopod 4.

**Diagnosis.**—Rostrum short, blunt; head with dorsal keel; body with paired dorsolateral processes of variable strength on pereonites 2-7; mid-dorsal carinae on pleonites 1 and 2, pleonite 3 dorsally keeled; epimeral plate 3 posterior margin serrate; maxilliped palp article 4 strong; gnathopod 1 articles 6 and 7 subequal in length.

**Description.**—Head, rostrum short, blunt; dorsal keel extends length of

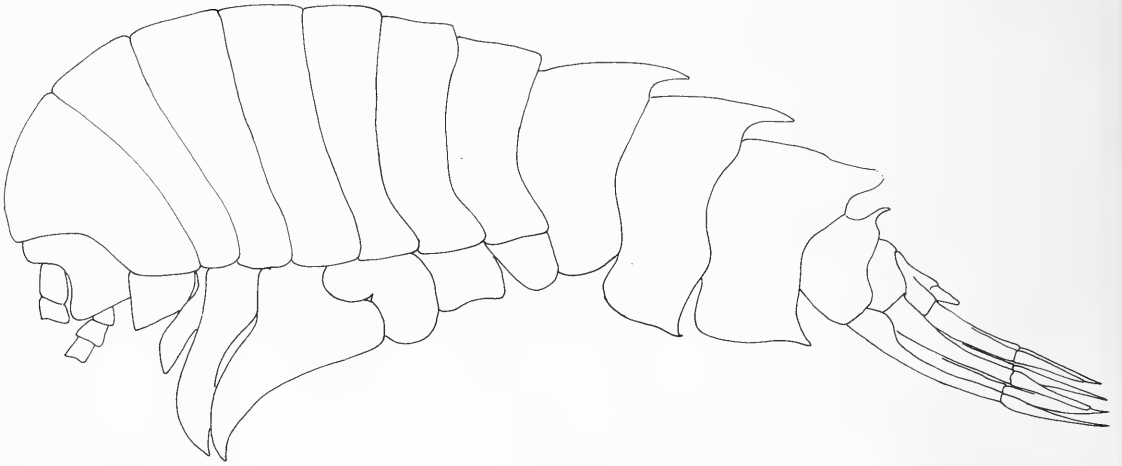


Fig. 26. *Parandaniexis dewitti*, female: Body, side view.

head; antennal angle subacute; eye slightly protruding, ommatidia not contiguous. Body with paired, low, sub-dorsal processes on pereonites 2–7. Pleonites 1 and 2 with mid-dorsal carinae; pleonite 3 dorsally keeled; epimeral plate 3 posterior margin serrate. Mandible molar strong, tritulative; incisor multidentate; lacinia mobilis of right mandible with 3 teeth; palp articles 2 and 3 elongate, subequal, with dense rows of setae along ventral margin; palp article 3 with proximal group of setae dorso-medially. Lower lip with nearly coalesced inner lobes; outer lobes broadly rounded, 1–3 blunt setae medially near apex. Maxilla 1 palp apex with 6 stout setae; inner plate with 4 short plumose setae terminally. Maxilliped palp 4-articulate; article 4 strong, as long as article 3; outer plate extends halfway along palp article 2; inner plate reaches base of palp article 2. Gnathopod 1 simple; coxa subacutely produced anteriorly; article 7 as long as article 6; article 5 proximally expanded. Gnathopod 2 similar to gnathopod 1 but slightly larger; coxa narrowly rounded distally. Coxa 4 broadly rounded distally, posterior margin excavate proximally. Telson entire.

*Etymology*.—The name refers to the small size of the species.

*Distribution*.—Known only from the locality listed above.

*Remarks*.—This species differs from the other species which have a short rostrum by the serrate posterior margin of epimeral plate 3 (smooth in *P. major*) and the narrow distal margin of coxa 2 (broadly rounded in *P. irregularis*). K. H. Barnard (1932) described an aberrant form and a variety (*miothele*) of *P. crenulata* which seem to be very similar to *P. minor*. Barnard's var. *miothele* differs from *P. minor* in having no pleural tubercles on the pereonites and a short non-deflexed rostrum which extends halfway along antenna 1 peduncle article 1. The aberrant form is described as having a short rostrum and, on pleonite 3, only a mediodorsal keel. Barnard does not indicate whether or not the rostrum is deflexed so it is not possible to determine its affinities with *P. minor*.

## Stegocephalidae

*Parandaniexis* Schellenberg*Parandaniexis* Schellenberg, 1929.*Type-species.*—*Parandaniexis mirabilis* Schellenberg, 1929.*Diagnosis* (from J. L. Barnard, 1969).—Mandible incisor smooth; maxilla 1 palp biarticulate; maxilla 2 outer plate not geniculate or gaping; maxilliped palp article 2 not produced; pereopods 5 and 6 article 2 slender; pereopod 7 article 2 broad; pereopod 4 subchelate; telson entire.*Parandaniexis dewitti* n. sp.

Figs. 26, 27

*Material.*—*Islas Orcadas* Cruise 575, Sta. 38, 22 May 1975, 57° 00.4'S, 26°10.1'W, 2,740–2,757 m, 2 ♀♀: holotype 42 mm, with eggs, USNM 173594; paratype 32 mm, USNM 173595.*Diagnosis.*—Body with strong mid-dorsal carinae on pleonites 1–3, elongate, thin, mid-dorsal tooth on urosomite 1; antenna 1 basal flagellar article only slightly longer than peduncle; pereopod 4 subchelate, propodus with slight proximal lobe on ventral margin.*Description.*—Ovigerous female. Head submerged in pereonite 1. Eye lacking. Body with strong mid-dorsal carinae on pleonites 1–3. Urosomite 1 with mid-dorsal elongate curved tooth. Epimeral plates 2 and 3 posterodistal corner acutely extended. Coxa 1 anteroventral corner subacute, posterior margin rounded. Coxa 2 subacute distally; coxae 3 and 4 anterodistal margins convex distally, posterodistal margins concave distally, both plates ventrally subacute.

Antenna 1 peduncle slightly shorter than basal flagellar article; uniaarticulate accessory flagellum extends more than halfway along basal flagellar article; main flagellum of 6 articles. Antenna 2 peduncle article 5 as long as flagellum; article 4 very short, as long as wide. Upper lip twice as wide as high, emarginate. Mandible incisor smooth, accessory tooth subtriangular, present in left mandible only. Lower lip lobes broadly rounded, with dense covering of fine setae. Maxilla 1 palp biarticulate, extending beyond outer plate; palp second article armed with short, stout setae along apex and distal half of medial margin; outer plate armed with elongate heavy spines; inner plate with 11 elongate, less robust setae. Maxilla 2 inner plate 3 times as wide as outer plate; outer plate distal setae non-plumose. Maxilliped palp 4-articulate, article 2 not produced, articles successively decreasing in length and width, outer plate broadly ovate, armed with short setae; inner plate short, reaching base of palp, medial margin armed with elongate setae. Gnathopods 1 and 2 simple; gnathopod 1 articles 5 and 6 subequal in length; gnathopod 2 article 6 longer than article 5. Pereopod 2 subchelate; propodus ventral margin excavate, bearing small proximal pro-

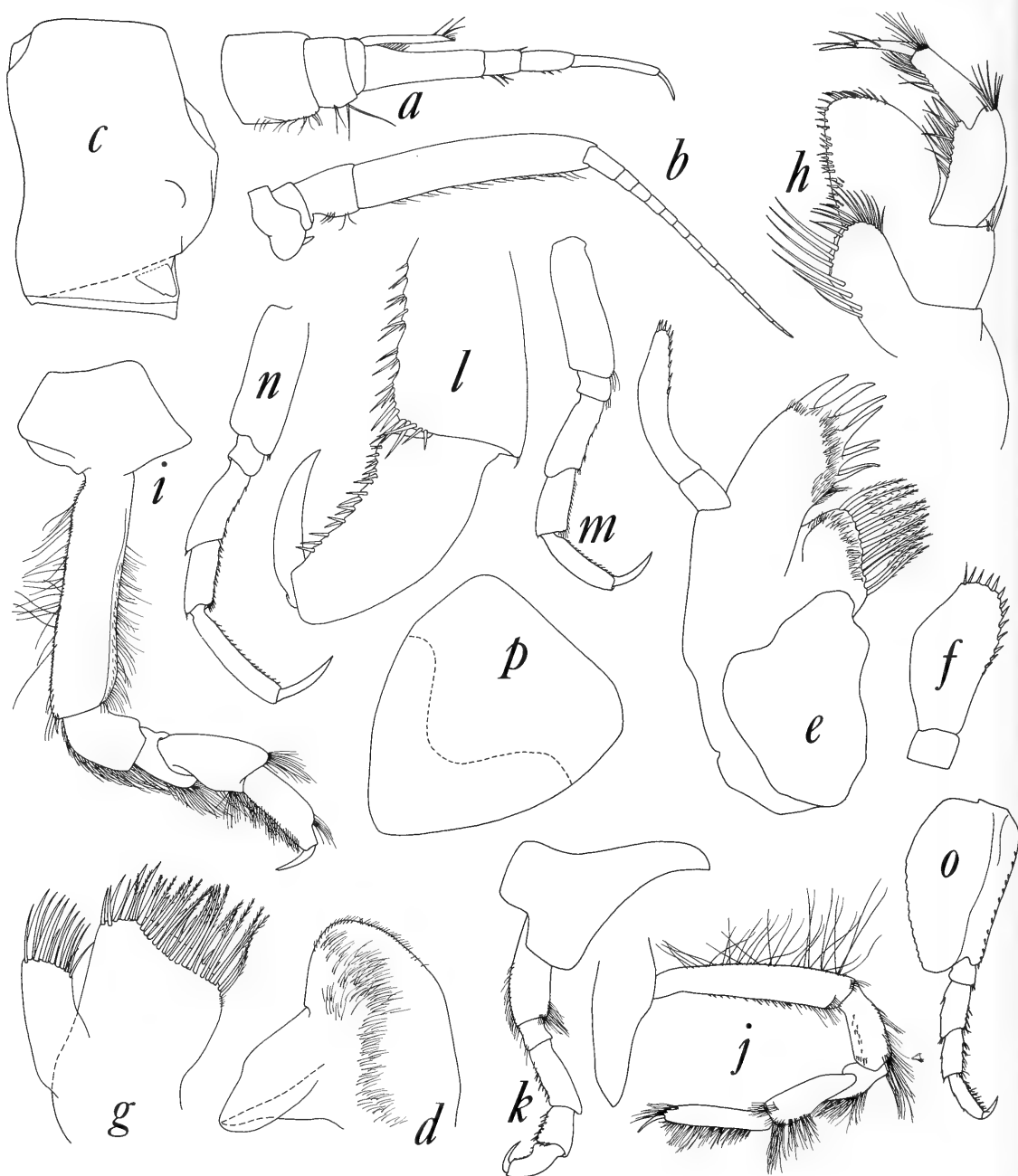


Fig. 27. *Parandaniexis dewitti*, female: a, Antenna 1; b, Antenna 2; c, Mandible; d, Lower lip; e, Maxilla 1; f, Maxilla 1 palp; g, Maxilla 2; h, Maxilliped; i, Gnathopod 1; j, Gnathopod 2; k, Pereopod 2; l, Pereopod 2 distal end; m, Pereopod 5; n, Pereopod 6; o, Pereopod 7; p, Telson.

tubercle with continuous row of short setae; articles 5 and 6 subequal. Pereopods 5 and 6, article 2 slender; pereopod 6 article 6 slightly longer than article 4. Pereopod 7 article 2 broad, tapering distally. Telson entire, apically subacute.

*Etymology*.—The species is named in honor of Dr. H. H. DeWitt, Chief Scientist for the cruise during which the specimen was collected.

*Distribution*.—South Sandwich Islands.

*Remarks*.—The subchelate pereopod 4 and the morphology of the mouthparts unquestionably places this species in the genus *Parandaniexis*. It differs from the only other known species, *P. mirabilis* Schellenberg by the shorter basal flagellar article of antenna 1, curved and acutely tapering coxae 3 and 4, large carinae on pleonites 1–3, and small ventral lobe on pereopod 4 propodus. The outline of the body is remarkably similar to that illustrated for *Andaniexis spinescens* (Alcock 1894). The latter species, originally placed in the genus *Andania* by Alcock, was moved to the genus *Andaniexis* by Stebbing (1906). It was so incompletely described, however, that its precise affinities are impossible to establish.

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# THE CALLS AND TAXONOMIC POSITIONS OF *HYLA GIESLERI* AND *OLOLYGON OPALINA* (AMPHIBIA: ANURA: HYLIDAE)

W. Ronald Heyer

**Abstract.**—The advertisement calls of *Hyla giesleri*, *H. microps*, *Ololygon catharinae* and *O. opalina* are described. The call data together with morphological differences indicate that *Hyla giesleri* is a species distinct from *H. microps*, with which it is currently placed, and that *Ololygon opalina* is a full species, not a subspecies of *Ololygon catharinae* as originally described. The calls in each species pair differ in several species specific coding features; small behavioral and morphological adjustments can account for these differences.

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Field recordings of advertisement calls of frogs from southeastern Brazil clarify the taxonomic positions of two species of hylid frogs, *Hyla giesleri* and *Ololygon opalina*. Duellman (1977) and Lutz (1973) included *Hyla giesleri* Mertens in the synonymy of *Hyla microps* Peters, following the synonymy of Bokermann (1966). Lutz (1968) described *opalina* as a new subspecies of *Hyla catharinae*. Lutz (1973) and Duellman (1977) maintained this relationship. I follow Fouquette and Delahoussaye (1977) and consider *catharinae* a member of the genus *Ololygon*. The data presented in this paper demonstrate that *Hyla giesleri* is specifically distinct from *Hyla microps* and that *Ololygon opalina* is a distinct species within the *Ololygon catharinae* complex.

## Methods and Materials

Field recordings made with an Uher CR-134 stereo cassette recorder were analyzed using a Kay Sonagraph model 6061 B, a Hewlett Packard 7402A strip chart recorder and a Brüel and Kjaer 2121 frequency analyzer. Specimens are deposited in the Museu de Zoologia, São Paulo, and National Museum of Natural History, Washington, D.C. (USNM).

### *Hyla giesleri*

The advertising call is intensity modulated, beginning relatively quietly and ending loudly. The call (Fig. 1A) consists of about 30 discrete pulses (two calls analyzed have 27 and 32 pulses) at an average pulse rate of about 100 per second. The duration of the entire call is about 0.3 s, and the du-

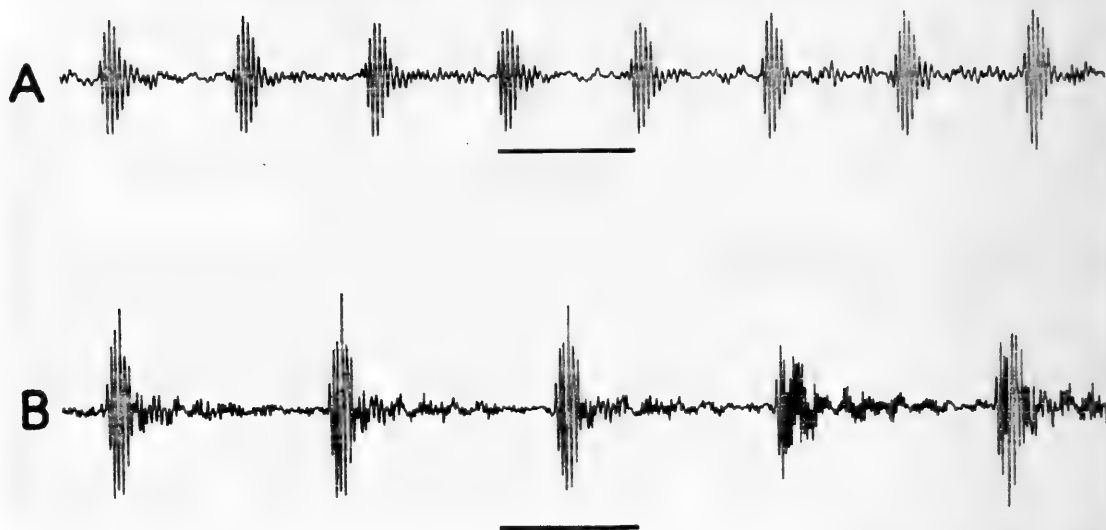


Fig. 1. Oscillographic strip chart recordings of portions of advertisement calls of (A) *Hyla giesleri* and (B) *Hyla microps*. Scale bars = 0.01 s. *Hyla giesleri* call from specimen USNM 208170 recorded at an air temperature of 20.5°C, Santa Teresa, Espírito Santo, Brazil. *Hyla microps* call from specimens USNM 208412-16 recorded at an air temperature of 19.5°C, Teresópolis, Rio de Janeiro, Brazil.

ration of individual pulses ranges from about 0.003 s at the beginning of the call to about 0.01 s towards the end of the call. The call has a complex spectral pattern, but does have a harmonic structure (Fig. 2A); the low frequency spectra presumably the fundamental (200–800 Hz range), and the high frequency spectra (3,000–3,800 Hz range) some multiple of the presumed fundamental. The dominant frequency at a temperature of 20.5°C ranges from a peak of about 3,000 Hz for the initial pulses in the call to a peak of about 3,600 Hz for the later pulses in the call.

The call of *H. giesleri* is similar to the call of *H. microps* in being pulsatile and having harmonic structure (Fig. 3). The calls differ distinctively in duration and dominant frequencies.

The call of *Hyla microps* is intensity modulated, starting out somewhat softly but quickly becoming and staying loud. The call consists of about 55–60 discrete pulses (Fig. 1B) at an average pulse rate of about 50 per second. The duration of the entire call is about 1 s, and the duration of individual pulses ranges from about 0.005 s for the initial pulses to about 0.01 s for pulses throughout the rest of the call. The call has a harmonic structure with a complex spectral pattern (Fig. 2B); it appears likely that the fundamental is in the 600–700 Hz range, with the dominant being the sixth harmonic. The dominant frequency at a temperature of 19.5°C ranges from about 4,600–5,300 Hz.

The recorded specimen of *Hyla giesleri* is part of a series taken at Santa

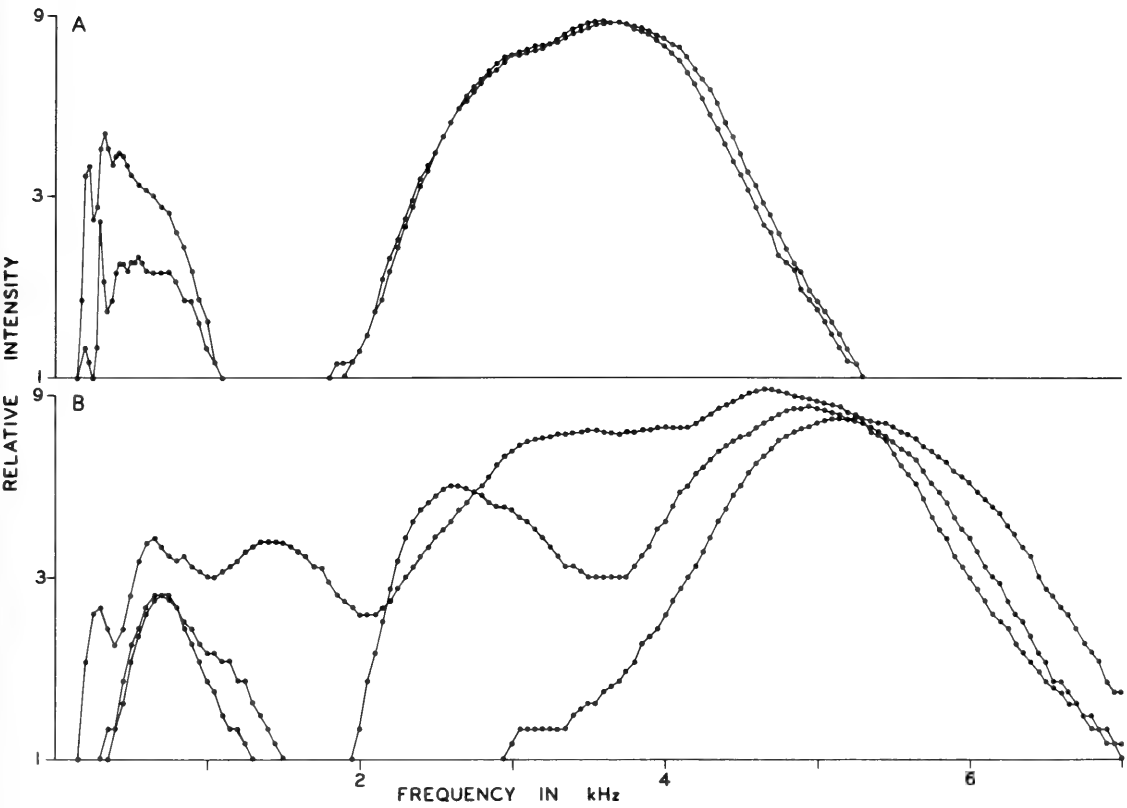


Fig. 2. Spectral analyses for advertisement calls of (A) *Hyla giesleri* (two calls) and (B) *Hyla microps* (three calls). The dots represent peak RMS meter readings at discrete frequency settings on the Brüel and Kjaer frequency analyzer, using a tape loop as the sound source. Specimen data same as for Fig. 1.

Teresa, Espírito Santo, Brazil. These specimens were compared with a toptype of *Hyla giesleri* at the USNM (taken by the collector of the type-specimens). Previously, *Hyla giesleri* had been reported only from the type-locality in the State of Rio de Janeiro, Brazil. Preserved specimens of *Hyla giesleri* are easily distinguished from those of *Hyla microps* by the presence in *H. microps* of a distinct white subocular spot or area on the upper lip. *Hyla giesleri* specimens lack a distinct white spot or area on the upper lip below the eye.

*Ololygon opalina*, new rank

The advertisement call begins quietly and builds in intensity. The call is pulsatile (Fig. 4A), but the pulses are not discrete. Because of the contrast in intensity between the beginning and ending of the call, only the louder ends of the calls appear on sonagrams (Fig. 5A). The entire call lasts about 0.7 s. Each pulse lasts about 0.03 s and is partially pulsed. The call has harmonic structure (Fig. 6A), with the sixth harmonic emphasized as the

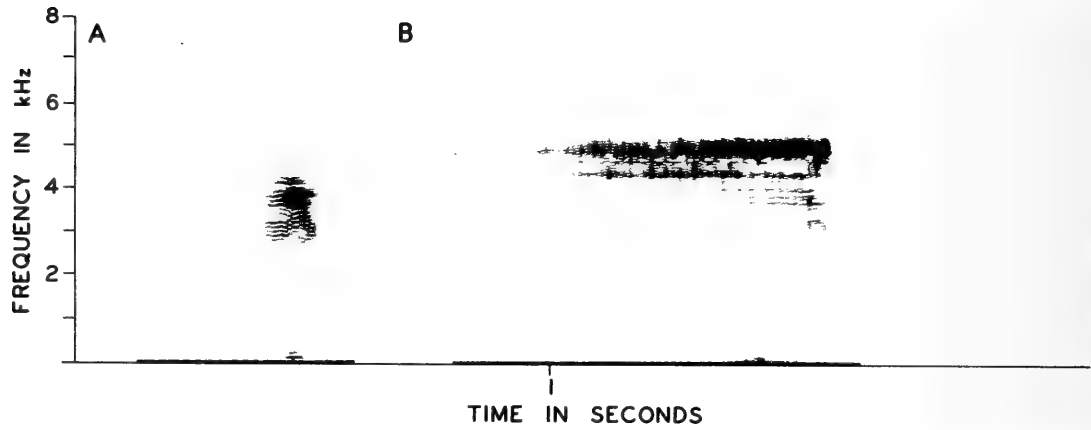


Fig. 3. Sonograms (narrow band) of advertisement calls of (A) *Hyla giesleri* and (B) *Hyla microps*. Specimen data same as for Fig. 1.

dominant frequency. The dominant frequency at 15.8° C varies from 3,300 to 4,100 Hz.

The call of *O. opalina* is distinct from the call of *O. catharinae* from Santa Catarina. The calls have a general similarity in starting out quietly

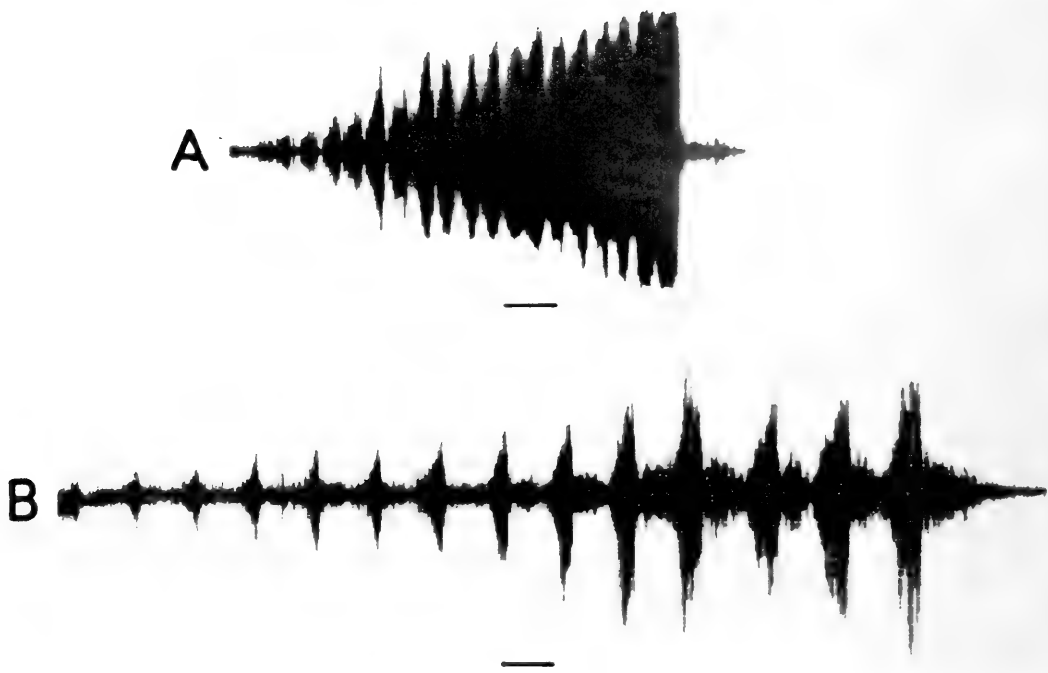


Fig. 4. Oscillographic strip chart recordings of advertisement calls of (A) *Ololygon opalina* and (B) *Ololygon catharinae*. Scale bars = 0.1 s. *Oloygon opalina* call from specimen USNM 208473 recorded at an air temperature of 15.8°C, Teresópolis, Rio de Janeiro, Brazil. *Ololygon catharinae* call from specimen USNM field no. 7359 recorded at an approximate air temperature of 22°C, Pirabeiraba, Santa Catarina, Brazil.

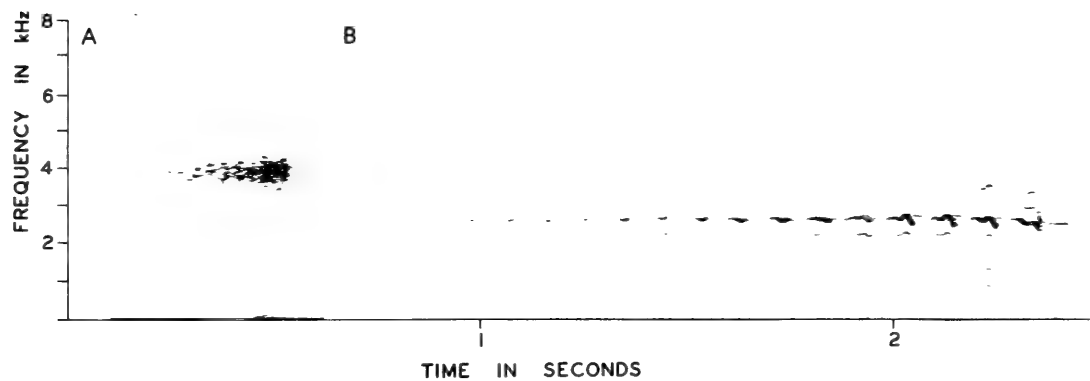


Fig. 5. Sonograms (narrow band) of advertisement calls of (A) *Ololygon opalina* and (B) *Ololygon catharinae*. Specimen data same as for Fig. 4.

and ending relatively loudly, in being pulsatile, and in having harmonic structure. In several details, the calls differ markedly as can be seen when they are compared (Figs. 4, 5, 6).

The call of *O. catharinae* begins very quietly and ends much more loudly

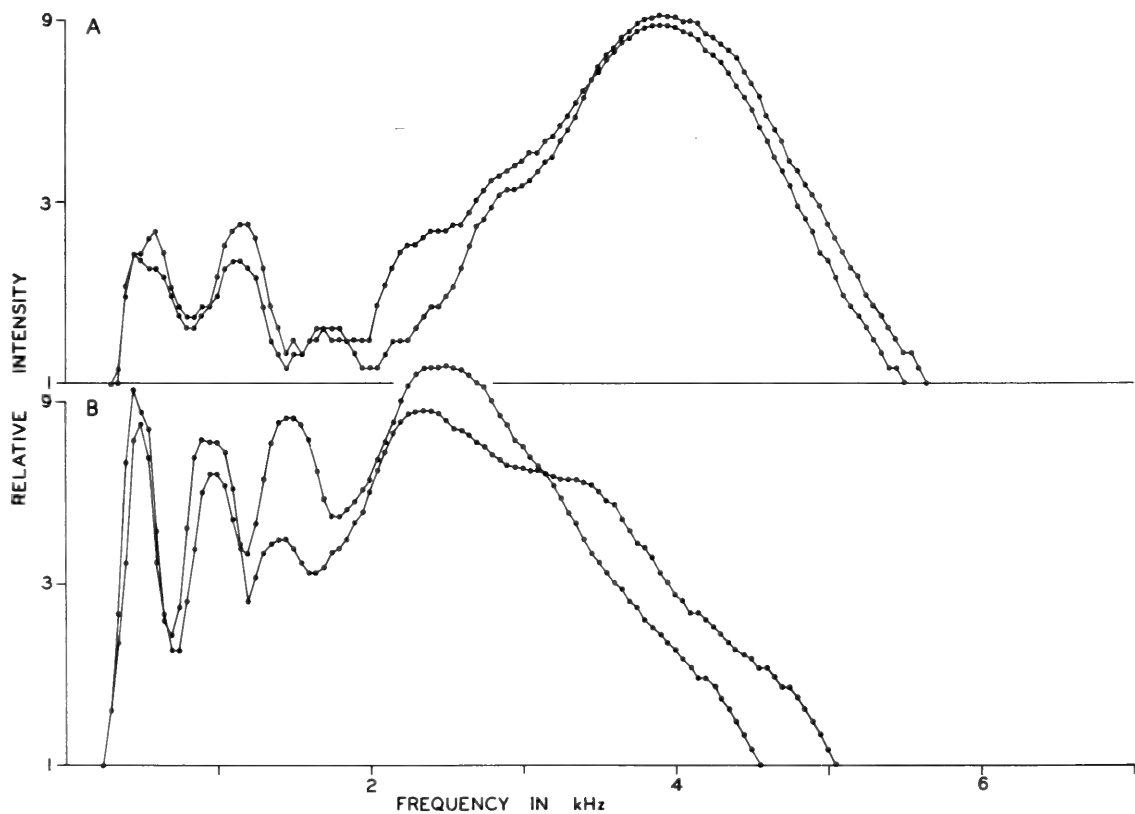


Fig. 6. Spectral analyses for advertisement calls of (A) *Ololygon opalina* (two calls) and (B) *Ololygon catharinae* (two calls). The dots represent peak RMS meter readings at discrete frequency settings on the Brüel and Kjaer frequency analyzer, using a tape loop as the sound source. Specimen data same as for Fig. 4.

(Fig. 4B). In the field, the first part of the call was not heard above the background of other chorusing frogs. Some frogs called from plastic bags after capture; only then was the first part of the call heard. The call consists of a number of separate pulses (Fig. 5B); each of the pulses has a relatively uniform intensity envelope, not distinctly pulsatile as in *O. opalina*. The entire call sequence lasts somewhat more than two seconds. The duration of a given pulse within the call lasts about 0.04 s. The pulses, particularly the latter, are frequency modulated (Fig. 5B). The call has harmonic structure (Fig. 6B), with either the fifth or sixth harmonic emphasized as the dominant frequency. The dominant frequency at about 22°C varies from 2,200 to 3,100 HZ.

The nominate subspecies of *O. catharinae* was described from the State of Santa Catarina, Brazil, where the recordings reported here were made. Lutz (1968) described a number of subspecies of *O. catharinae*, one of which (*simplex* = *obtriangulata*), she later (1973) raised to a full species. The call data presented here demonstrate that the subspecies Lutz (1973) defined as *catharinae* and *opalina* differ at the species level. There remain three subspecies as defined by Lutz (1973) for which the status is still unclear: *O. c. bocainensis*, *O. c. brienii*, *O. c. trapicheiroi*.

Specimens of *O. catharinae* and *O. opalina* are easily distinguished by color pattern. The dorsum of *O. opalina* is rather uniform; the groin region of bold dark and light markings contrasts markedly with the surrounding sides and dorsum (for a color photo, see plate V in Lutz 1973). The dorsum of *O. catharinae* consists of a series of alternating dark and lighter brown transverse bands (similar to those seen in *O. c. brienii* and *O. humilis* as photographed in plate V of Lutz 1973); the groin area has an intensification of the dorsal pattern, but there is no contrast between the dorsal and lateral pattern with the groin pattern.

### Discussion

The species discussed represent morphologically similar species pairs. The morphological similarity presumably indicates close phyletic relationships. For each species pair, a common call pattern can be derived, yet there are at least three aspects of the calls for both species pairs where differences are sufficient to code species specific information. These differences are: (1) call duration, (2) pulse rate, and (3) dominant frequency channel. In addition, there is a pulsatile difference within notes for *O. catharinae* and *opalina* that could code species specificity. All of these call differences can be accounted for by relatively small adjustments in the calling apparatus. For example, differences in call duration and pulse rate are under neuromuscular control; small changes in behavior of this system could lead to the call differences seen. The frequency differences and pulsatile structure

within note differences could be accounted for by small morphological changes in the vocal cords and/or vocal sac. Thus it appears that at least one premating isolating mechanism in frogs can evolve through fine tuning of a functional system; major changes are not required.

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## TWO NEW LAMIPPID COPEPODS PARASITIC ON GORGONIANS FROM HAWAII AND THE BAHAMAS

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*Abstract.*—Descriptions are presented of *Linaresia magna*, new species, and *Sphaerippe caligicola*, new genus and species, gorgonian-inhabiting lamippid copepods parasitic within galls on a Hawaiian *Placogorgia* and a Bahaman *Callogorgia* respectively. *L. magna* is the first lamippid described from the Pacific. It differs from the two previously known species of *Linaresia* in its greater size, in the shape of the lateral arms and lack of ventromedial knobs in the female, and in details of setation. It lives in galls formed from individual host polyps, with a density of 0.42 individuals per centimeter of host skeleton. The sex ratio is nearly even; spermatophores are attached in pairs to the females and eggs are found in loose bundles within the galls. Some specimens are associated with the ascothoracican cirriped *Gorgonolaureus*. The new genus *Sphaerippe* is distinguished by a globular female, bands of papillae on the male, no maxillipeds, broad, weakly segmented second antennae, a short furca with spines, and multidigitate thoracic limbs with acicules. *S. caligicola* lives as a male-female pair within a boot-shaped gall. Several egg masses containing about 40 eggs each are found within the gall.

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The Lamippidae are a small family of poecilostome copepods parasitic within various Octocorallia. Those found in the vicinity of Banyuls-sur-Mer, France, are the best known, having been studied by de Zulueta (1908, 1910, 1911), Bouligand & Delamare-Deboutteville (1959a, b), and Bouligand (1960a, b, 1961, 1965). The most extensive recent review is that of Bouligand (1966). Here he recognized two genera, *Lamippe* (subgenera *Lamippe*, *Lamippula*, *Lamippina*, *Lamippella*, *Enalcyonium*, and *Isidicola*) and *Linaresia*. Except for *Lamippula*, which was newly defined, the subgenera of *Lamippe* were previously of generic rank. Stock (1973) reestablished all these taxa as genera and presented a key for distinguishing them. A representative of a new genus, *Magnippe*, has recently been described by Stock (1978).

The two new lamippids described in this paper were discovered fortuitously while I was examining gorgonians for gallicolous ascothoracican cirripeds. Ms. Katherine Muzik of the Museum of Comparative Zoology at Harvard University sent me dried branches of a new *Placogorgia* (n. sp. A) from off Makapuu Point, Oahu, Hawaii, where they had been collected

by Boh Bartko in the *Star II* submersible at 366 meters. This dried material was reconstituted overnight in a trisodium phosphate solution. Some ascothoracicans (*Gorgonolaureus* sp.) were present in a few large galls, but much more numerous smaller galls contained peculiar stellate animals that could be assigned to the lamippid genus *Linaresia*. The two species of this genus previously known are *L. mammillifera* de Zulueta (1908) and *L. bouligandi* Stock (1979) from the Mediterranean coast of Spain and the west coast of Florida, respectively. This is the first lamippid known from Hawaii, and, aside from undescribed species present at La Jolla, California (Taylor, unpublished) and at Corona del Mar, California (Illg, personal communication), it is the first from anywhere in the Pacific.

Dr. Frederick Bayer of the Smithsonian Institution sent a collection of gorgonian-associated ascothoracican material including a stalk of *Callogorgia* (USNM Acc. no. 295887) from off Grand Bahama Island with a small, boot-shaped growth on it. This gall contained a pair (male and female) of lamippid copepods, rather than ascothoracicans; these specimens are described herein as representatives of a new genus, *Sphaerippe*. A number of lamippids are already known from the West Atlantic and the Caribbean (Patton, 1963; Dudley, 1973; Stock, 1973, 1978, 1979).

All figures were drawn by the author with the aid of a camera lucida from whole specimens mounted and cleared in lactic acid, or in some cases for *Linaresia*, dissected specimens mounted in glycerol or Turtox CMC-10 with acid fuchsin.

### *Linaresia* de Zulueta

#### *Linaresia magna*, new species

##### Fig. 1

*Material*.—Holotype, ♀, at U.S. National Museum of Natural History, USNM 173711; Paratypes: 15 ♀♀, 15 ♂♂, and a *Placogorgia* branch with unopened galls, USNM (for the lot) 173712; 15 ♀♀, 15 ♂♂, at Museum of Comparative Zoology, Harvard University; numerous ♀♀ and ♂♂ and unopened galls retained at Scripps Institution of Oceanography.

*Type-locality*.—About 10 kilometers east of Makapuu Point, Oahu, Hawaii (21°19'N, 157°34'W), at 366 meters depth. Taken by Boh Bartko in *Star II* submersible in 1979.

*Distribution*.—Known only from type-locality.

*Host*.—Endoparasitic in *Placogorgia* sp.

*Etymology*.—From Latin *magnum* (=large), referring to the animal's size relative to its congeners.

*Description*.—Female (Fig. 1a–g): Length varying due to uneven shrinkage in dried state, 1.4–2.3 mm, averaging 1.9 mm (n = 30) not including furca or lateral processes. Body (Fig. 1a) yellow to amber in color, outline

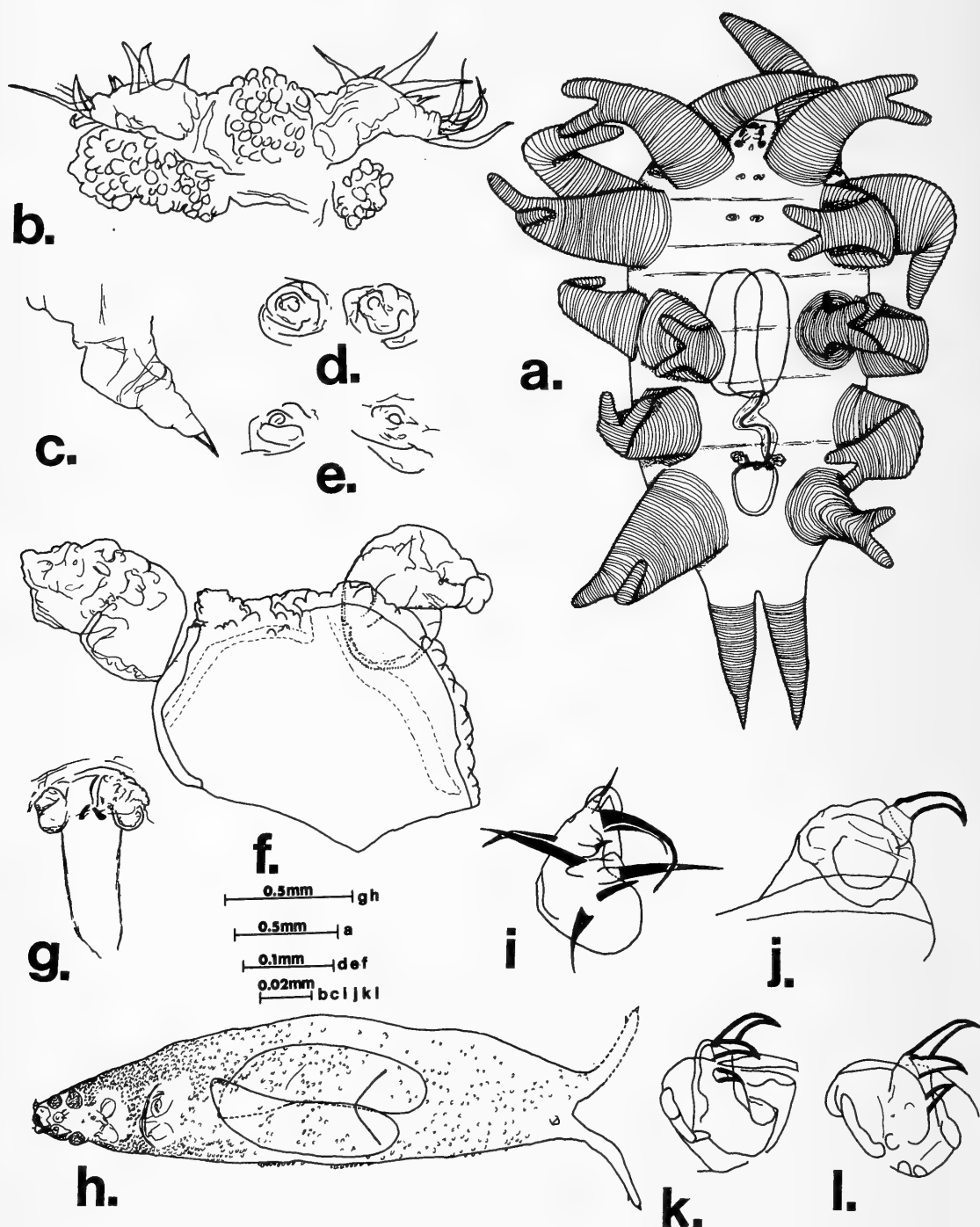


Fig. 1. *Linaresia magna*: a–g, Female; h–l, Male: a, Ventral aspect of female, reconstruction, anterior end uppermost, showing pair of spermatophores with duct leading to genital apparatus; b, First antennae, ventral aspect, including the 3 most anterior papillate tubercles; c, Second antenna, ventromedial aspect; d, First pair of thoracopods, ventral aspect; e, Second pair of thoracopods, ventral aspect; f, Female genital apparatus (genital plate and vulvae), ventral aspect, genital plate displaced somewhat to left during mounting; g, Same as f with genital plate removed to show clavate projections between vulvae and depression which accomodates convex upper surface of plate; h, Ventral aspect of male, anterior end at left, showing spermatophores within body and terminal swelling at base of furca; i, First antenna, median aspect; j, Second antenna, median aspect; k, First thoracic limb, lateral aspect; l, Second thoracic limb, lateral aspect.

variable, but typically roughly rectangular, twice as long as wide, tapering slightly posteriorly to a furca. Each furcal ramus about 1 mm long with annulate ridges, tapering to a spine. Sixteen lateral processes (arms) along sides of body arranged into 5 sets along each side; all arms about 1 mm long, cylindrical with annulate ridges, tapering to blunt ends. First 3 pairs each with biramous ventral and uniramous dorsal element. Posterior tip of biramous arm slightly narrower and longer than anterior, bifurcation occurring in distal quarter of arm. Last 2 pairs with only biramous ventral element, last pair wider than the others. Arms produced laterally, but usually bent ventrally. Other external features including 2 pairs of antennae, oral cone, 2 pairs of thoracic limbs, and genital plate ("terminal swelling" of Bouligand, 1966) with associated structures. Ventral surface with several transverse folds or ridges, which, together with intervening cuticle, bear minute slits and depressions, triangular in side view, and more common anteriorly. Antennae and oral cone between first pair of arms; first antennae on anteriormost end of animal. Five papillae-laden tubercles anteriorly, 1 dorsal of first antennae, 2 lateral between pairs of antennae, and 2 lateral posterior to second antennae. First thoracic limbs equidistant between oral cone and second thoracic limbs, latter between second pair of arms. First antennae (Fig. 1b) 0.05 mm long, directed laterally. Five setae on anterior border and 5 more terminal, short but not spinelike. Segmentation obscure, possibly 2 segments. Second antennae (Fig. 1c) slightly larger and conical, segmentation obscure, single hooked claw at tip. Oral cone a very small projection antero-posteriorly elongate. Thoracic limbs (Fig. 1d–e) reduced to nipplelike structures lacking setae. Genital apparatus (Fig. 1f) just anterior to last pair of arms. Plate roughly pentagonal, 0.3 mm wide and slightly longer, with convoluted anterior edge. Plate prehensile, with rear edge anchored and upper side convex. Vulvae at anterior corners of plate, bulbous part of each partly overlain by plate; tapered lateral part of each free. A pair of narrow, clavate projections pointing posteriorly from beneath anterior edge of plate (Fig. 1g).

Male (Fig. 1h–i): Length 0.9–1.6 mm, averaging 1.3 mm ( $n = 27$ ) not including furca. Body (Fig. 1h) yellow to amber in color, fusiform, tapering more anteriorly than posteriorly; widest point (0.5–0.6 mm) at midlength. A posterior furca, each ramus stout and tapering, with a terminal and external subterminal spine. Furcal rami 20–25% as long as rest of body. Other appendages including 2 pairs of antennae and 2 pairs of thoracic limbs anteriorly; also spherical ventral protrusion (terminal swelling) just anterior to furca. Transverse genital slit ventrally, just posterior of widest point of body, bowed slightly forward in middle. Papillae covering integument, but sparse posteriorly and on ventral surface near thoracic and cephalic appendages. Five papillae-covered tubercles at anterior end arranged as in female. First antennae (Fig. 1i) 0.06 mm long, with no apparent segmentation, conical with 1 baso-medial seta, 2 long and 2 short setae in center of

medial side, 1 seta on middle of anterior side or on medial face, and 2 long and 1 short terminal setae. All setae stout and tapering to a point. Second antennae (Fig. 1j) of same dimensions as first, with indistinct basal segment, spherical segment with sclerites, and slightly bulbous distal segment bearing stout, hooked claw. Mouth posterior to second antennae, reduced to minute indented oval. Mandibles, maxillae, and maxillipeds absent. First and second thoracic limbs (Fig. 1k-l) about same size as antennae. Protopodites with sclerites. Exopodites with 3 claws, 2 terminal and smaller one between and proximal to these on posterior side. Endopodites absent. Interpodal plate connecting each pair of limbs across midline.

*Remarks.*—The 5 papillate cephalic tubercles, the simple tapering furcal rami, and the pronounced development and precise arrangement of the female lateral processes (arms) are diagnostic of the genus *Linaresia* de Zulueta (1908). Two other species are known, *L. mammillifera* de Zulueta (1908), the type-species of the genus, and *L. bouligandi* Stock (1979).

The female of *L. mammillifera* is more rotund than that of *L. magna*. Its length is only 1.1 mm, 40% shorter than the new species. The arms of *L. mammillifera* are capitate, unlike *L. magna*, where they taper gradually. On bifurcate arms, the posterior branch is clearly subordinate in *L. mammillifera*, being acapitate and set off at a right angle. In *L. magna* there is a slight asymmetry, but no obvious subordination between the bifurcate tips. The first antennae of the female *L. mammillifera* lack a subterminal seta found in *L. magna*, and the thoracic limbs are slightly less degenerate in the former species. Three enigmatic structures are arranged serially on the ventral side of the *L. mammillifera* female posterior to the thoracopods. The anterior 2 are round knobs situated medially, while the posterior one may also be on the midline, or be manifested in other individuals as a paired structure. Stock (1978) considers these to be rudimentary limbs. These structures are absent in *L. magna*. The furcal rami of the male *L. mammillifera* are proportionately longer than those of *L. magna*, and its main body is only half as long as the present species. There are 2 extra setae on the medial side of the first antennae in *L. magna* males. No mention is made of a terminal swelling in the males of *L. mammillifera*.

Only the female is known of *L. bouligandi*. Its main body is 0.5–0.6 mm long, much smaller than *L. magna*. The body outline is also more rotund. The arms are proportionately longer and narrower than in *L. magna*, and have wider annulations. The bifurcations of the ventral arms are very long compared to *L. magna*. The first antennae are more reduced in *L. bouligandi*, with only 0–3 setae, compared to 10 in *L. magna*. The claw on the second antenna is bifid in *L. bouligandi*, but simple in *L. magna*. Two medial swellings on the ventral surface, similar to those in *L. mammillifera*, are found in *L. bouligandi*, but not in *L. magna*. According to Stock (1979), *L. bouligandi* has 2 arcuate sclerites connected by a straight, transverse

sclerite some distance anterior of the genital plate ("terminal swelling"). He tentatively labelled this structure the vulva, citing Bouligand & Delamare-Deboutteville (1959a). The structure on *L. mammillifera* referred to by Stock was in later papers by Bouligand redescribed as the third (single or paired) ventral knob, discussed above. Bouligand (1960a) showed that the oviducts open at the true vulvae, the structures at the anterior corners of the genital plate. Stock's "vulva" is probably homologous to the third ventral knob in *L. mammillifera*, and is probably not a reproductive structure. The structure is lacking in *L. magna*. The genital plate is situated at the extreme posterior end of the body in *L. bouligandi*, rather than farther forward as in the other 2 species. In all 3 species the position of the genital plate is fairly constant relative to the last pair of arms. There is apparently no armanent of the furcal rami in *L. bouligandi*.

*Life cycle*.—Many males have a pair of spermatophores developing within chambers that are one-third the length of the animal (0.8 mm). The spermatophores must exit through the ventral transverse slit. They are attached in pairs by a cord to the female. Attachment may be at various places on the underside, but usually just in front of the genital plate. This cord is over 1 mm long and is twisted; it contains the ducts leading from each spermatophore. These may join distally, or they may remain separate for most of the length of the cord. The duct narrows greatly at the point of attachment. No sperm were seen. Spermatophores attached to the female (Fig. 1a) are 0.6 mm long and reniform.

Most females are associated with eggs, either loosely attached within the gall or confined in thin membranous sacs on the underside of the female. Egg sacs are not reported from either of the other species of *Linaresia*. The eggs are about 0.14 mm in diameter. One was seen with a developing nauplius inside. It was impossible to see much detail, but the larva did have 3 pairs of appendages with 3–5 terminal setae per ramus. Stages intermediate between the male and female are known for *L. mammillifera* (Bouligand, 1960a), but not in *L. magna* or *L. bouligandi*. It is possible, though, that all 3 species are protandric hermaphrodites.

*Ecological notes*.—Each gall corresponds to a single polyp. *L. magna* apparently does not live within the polyp, for a membrane separates the gastro-vascular cavity of the polyp from the space within which the copepod is living. The dorsal side of the female is appressed to the gorgonian's axis, with the body lined up longitudinally, producing a lenticular swelling of the gorgonian's bark. Unlike *L. mammillifera*, there are no cases of the arms of the parasite being exposed and possibly simulating a missing polyp.

Each gall contains a female and, usually, a male (rarely 2 or 3) and eggs. Solitary males were found, but not within galls. Often there were one or more females associated with galls formed by an ascothoracican cirriped (*Gorgonolaureus* sp.). Here there were no enlarged polyps; the parasitic

copepod lived between the valves of the ascothoracican and the gorgonian tissue covering it. In order to estimate the degree of infestation, branches of the gorgonian totalling 139 mm in skeletal length were thoroughly searched for copepods; 59 individuals were found, corresponding to a density of 0.42 copepods per centimeter of host. Thirty-one of these were females and 28 males, suggesting a 1:1 sex ratio.

The host of *L. mammillifera* is *Paramuricea clavata* of the family Paramuriceidae (potentially confusing name change of this gorgonian explained in Stock, 1979). Both *L. bouligandi* and *L. magna* are found in *Placogorgia* species, also in the Paramuriceidae. It is too soon to tell, however, whether *Linaresia* is confined to this one family of gorgonians. Both *L. mammillifera* (subtidal) and *L. bouligandi* (76 m) are from shallow waters, while *L. magna* (366 m) is from bathyl depths. The 3 species of *Linaresia* currently encompass the Mediterranean, Western Atlantic, and Indo-West Pacific biogeographical provinces. This may be construed as a Tethyan distribution, in which case it is reasonable to expect that more species will be discovered at similar latitudes in the future.

### *Sphaerippe*, new genus

*Diagnosis*.—Lamippid copepods endoparasitic within a gall on a gorgonian (*Callogorgia* sp.). Sexually dimorphic, female much larger than male and with slightly different armament on appendages. Female globose, with slight anterior appendage-bearing protrusion; male less rotund, with more prominent appendage-bearing protrusion and 5 bands of papillae around trunk. Both sexes with biarticulate first antennae (single spine on basal segment, many on terminal segment); broad, weakly biarticulate (possibly triarticulate in female) second antennae terminating in hooked claw; 2 pairs of thoracopods with uniarticulate protopodites, exopodites, and endopodites; and separated furcal rami, conical, with a subterminal and 4 terminal spines. Maxillipeds absent. Thoracic endopodites of both sexes well-developed with palmately arranged digitations, each terminating in an acicule. Exopodites similar to endopodites, but with more digitations. Sometimes inexact symmetry of numbers of digitations on left and right sides of animal, and males possessing more digitations than females.

*Remarks*.—*Sphaerippe* differs from *Linaresia* and *Magnippe* Stock (1978) in not having the lateral arms that give the females of these two genera stellate appearances. *Lamippe* Bruzelius (1859) and *Isidicola* Gravier (1914) have well-developed maxillipeds, which are lacking in *Sphaerippe*. *Lamippina* Bouligand (1960) has well-developed thoracic endopodites like *Sphaerippe*, but also has rudimentary maxillipeds, furcal acicules, and a clearly articulated second antenna with 3 segments in both sexes, conditions found wanting in *Sphaerippe*. *Lamippula* Bouligand (1966) lacks maxillipeds but has furcal acicules and long, clearly segmented first and second



antennae, contrary to the condition found in *Sphaerippe*. *Enalcyonium* Olsson (1869) is similar to *Lamippula*, though lacking furcal acicules, but otherwise distinguishable from *Sphaerippe* by the same criteria as *Lamippula*. *Lamippella* Bouligand & Delamare-Deboutteville (1959) is the closest of the known genera to *Sphaerippe* in lacking maxillipeds and furcal acicules and in having circular rows of papillae and poorly segmented antennae, but it has reduced, unarmed endopodites on its thoracic limbs, contrasting with the well-armed endopodites of *Sphaerippe*. *Sphaerippe* is much more rotund than any other genus, and, aside from *Isidicola*, is the only relatively unmodified lamippid to live in a gall (Gravier, 1914). Pronounced sexual dimorphism has previously been known only in *Linaresia* and *Lamippina*, through there is a size difference between the sexes in *Lamippe* (Bouligand, 1966).

*Etymology*.—From Latin *sphaera* (=sphere) and the ending of *Lamippe*, the type-genus of the family Lamippidae, referring to the globular shape of the female. Gender feminine.

*Type-species*.—*Sphaerippe caligicola*, new species.

*Sphaerippe caligicola*, new species

Fig. 2

*Material*.—Holotype, ♂, USNM 173709; Paratype, 1 ♀ with eggs, USNM 173710.

*Type-locality*.—Off Southwest Point, Grand Bahama Island (26°31'N, 98°51'W). Taken at 366 meters on 14 February 1965; *Gerda* Station 503.

*Distribution*.—Known only from type-locality.

*Host*.—Endoparasitic within a gall on *Callogorgia* sp.

*Etymology*.—From Latin *caliga* (=boot) and Latin *-icola* (=an inhabitant), referring to the boot-shaped gall within which the copepod lives.

*Description*.—*Male* (Fig. 2a–d): Body (Fig. 2a) ellipsoidal, 0.62 mm long and 0.32 mm wide, with anterior end protruding. Color white. Cuticle smooth except for 5 bands of hemispherical papillae encircling trunk. Two pairs of antennae, oral cone, and 2 pairs of thoracic limbs near anterior end, ventral transverse genital slit just anterior to fourth band of papillae, and pair of short furcal rami also present. First antennae (Fig. 2b) 0.05 mm long, biarticulate. Basal segment with 1 short, median seta, terminal segment with 8 short setae. Second antennae (Fig. 2b) 0.06 mm long, with bulbous base and short, conical second segment terminating in strong, hooked claw. Oral cone round, covered by labrum with straight posterior edge. From posterior opening, oral cavity leading forward to center of cone, then straight into body; this cavity distally a transverse slit, but proximally, bifurcation at each end of slit may reveal pair of mouthparts not protruding past posterior edge of labrum. Maxillipeds absent. First thoracic legs (Fig. 2c) biramous,



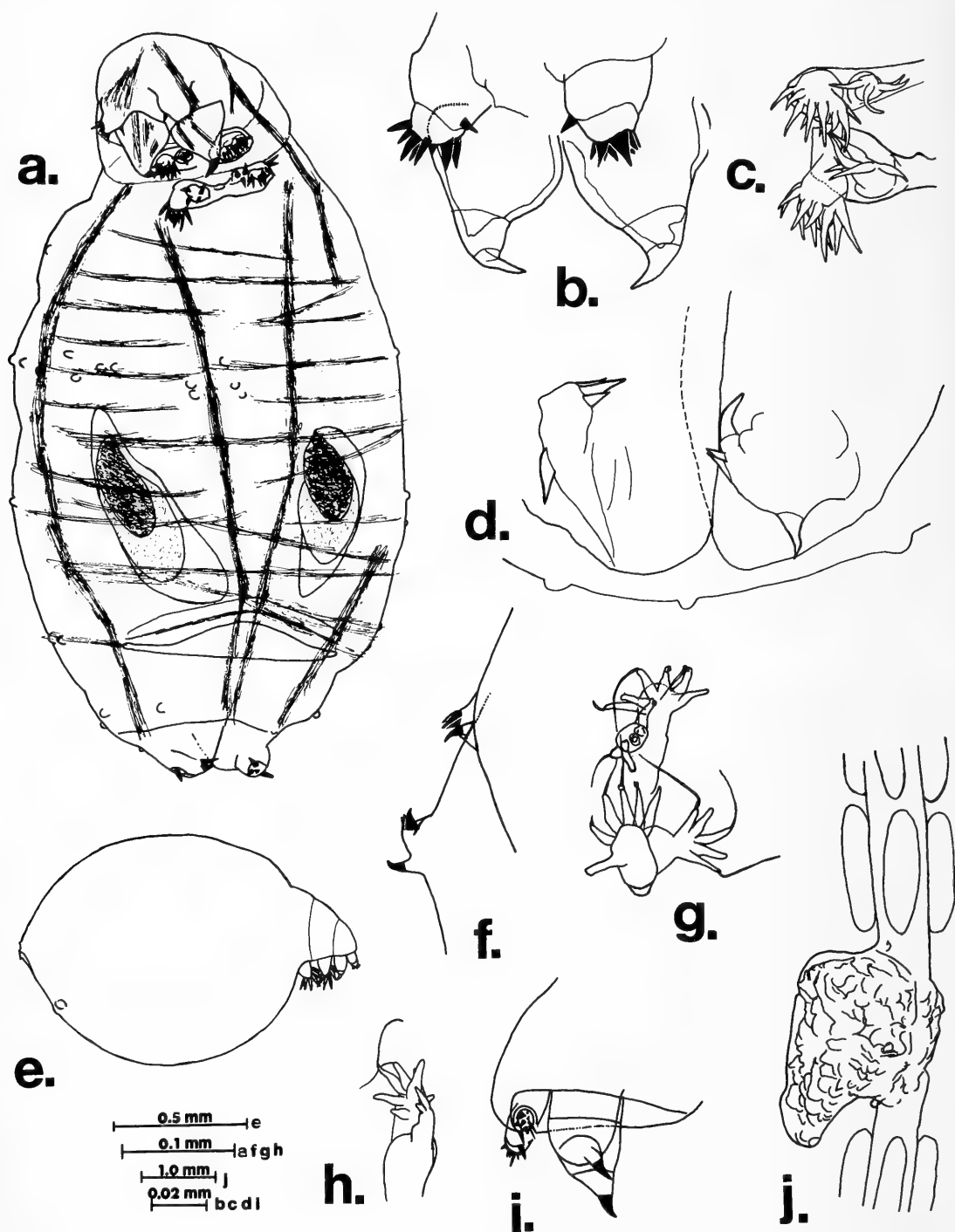


Fig. 2. *Sphaerippe caligicola*: a–d, Male; e–i, Female: **a**, Ventral aspect of male (Holotype) showing developing spermatophores and bands of papillae (more papillae present than shown here); **b**, First (above) and second (below) antennae, antero-lateral aspect; **c**, Right first (above) and second (below) thoracopods, ventral aspect; **d**, Furca, ventro-posterior aspect; **e**, Lateral aspect of female (Paratype), showing vulvae below and anterior to furca; **f**, Furca, ventro-lateral aspect; **g**, Right (above) and left (below) second thoracopods, ventro-lateral aspect, with exopodites oriented vertically, showing extended acicules; **h**, Right first thoracopod, medial aspect, showing acicules; **i**, First (left) and second (right) antennae on anterior end of body; **j**, Gall in place of *Callogorgia*, ovals representing stylized polyps.

with uniarticulate protopodites, exopodites, and endopodites. Interpodal plate connecting this pair across midline. Endopodite and exopodite terminating in digitations (integral parts of segment, not spines or setae) that are slightly bulbous basally, presumably with a retracted acicule at tip of each. Right endopodite of first pair of legs with 4 digitations, right exopodite with 11, left endopodite with 4, and left exopodite with 12. On second pair (Fig. 2c) components similar to those in first, except interpodal plate more pronounced. Right endopodite with 5 digitations, right exopodite with 10, left endopodite with 5, and left exopodite with 9. Digitations arranged palmately on all limbs, 2 rows on exopodites. Genital slit bowed slightly forward in middle. Furcal rami (Fig. 2d) separated on buttocklike lobes, each ramus a flabby cone with 1 large and 2 small terminal spines and 1 subterminal lateral spine as large as largest terminal one.

Internal structure including 4 longitudinal muscle bands, many circular muscles, and pair of developing spermatophores anterior to genital slit. Muscles present in antennae and limbs. Each row of papillae on slight annulus probably representing a segment, but perhaps only reflecting a state of arrested peristalsis.

*Female* (Fig. 2e–i): Body (Fig. 2e) globose, 1.24 mm long with anterior end protruding slightly. Surface smooth. Other features arranged as in male except for genital apparatus. First antennae (Fig. 2i) 0.05 mm long, cylindrical with median seta on first segment and many very short setae on second. Second antennae (Fig. 2i) twice as long as first, apparently biarticulate (suture around cylindrical basal segment perhaps indicating that 3 segments are present), with hooked claw at tip. Oral cone and mouthparts not observed due to difficulty of obtaining ventral view. Thoracic limbs similar to males except for number of digitations and presence of an extended acicule on many of them. Distribution of digitations as follows: on first pair (Fig. 2h), exopodites with 7 and endopodites with 2; on second pair (Fig. 2g), exopodites with 6 and endopodites with 5. Furca (Fig. 2f) as in male. Vulvae anterior to furca, but still on posterior side of sphere, hemispherical knobs on each side of midline with 2 arcuate sclerites surrounding opening on each.

*Remarks.*—*Sphaerippe caligicola* is distinguished from other lamippids because of its rotundity (other lamippids are sausage-shaped to vermiform), and the acicule-bearing digitations of the thoracic limbs are quite unusual. *Lamippina aciculifera*, as its name implies, bears many acicules, including some on digitations of its thoracic limbs (Bouligand, 1961), but there are also normal setae and claws on its limbs, as well as additional acicules on the furca. Many other lamippids bear acicules, either on the furca (for examples, see de Zulueta, 1908) or over the body surface (*Enalcyonium chattoni*), but on these, the endopodite is reduced and naked, or, at most, armed with a few normal setae. The combination of acicule-laden thoracic limbs

and furcal rami armed only with spines is unique to this new species of lamippid.

The asymmetry in the number of digitations, at least in the male, may limit the value of this character in distinguishing *S. caligicola* from any undiscovered species in the genus *Sphaerippe*.

*Effect on host.*—The axis of the *Callogorgia* host has polyps arranged in rings of 4, the rings spaced 2 mm apart. The gall containing the pair of copepods took the place of one of these rings. The gall (Fig. 2j) was boot-shaped, with the "sole" distal and parallel to the axis. It extended 1.3 mm away from the axis, was 3 mm long, and was covered with spicules like the rest of the gorgonian. No external opening was present. The inside of the gall was lined with a membrane with a 6-fold symmetry in cross-section at the "toe." It is not known whether this membrane was secreted by the host or the parasite.

*Life cycle.*—Five egg clusters totalling 198 eggs were found within the gall distal to the axis along the "sole" and within the "toe" of the boot. Dimensions of the eggs averaged  $110 \times 80 \mu\text{m}$ . The female had a large number of oocytes within its ovaries, and a pair of spermatophores was being produced by the male. No empty spermatophores were found; nor were any larvae, developing or hatched. It may be that this species of lamippid mates for life, since the male and female are enclosed in a common gall. Alternatively, the male's small size and more formidable armament may allow it to break out of the gall and reinvade the same or another gorgonian as a female. Such a system of protandric hermaphroditism has so far been demonstrated only in *Linaresia mammillifera* (Bouligand & Delamare-Deboutteville, 1959a; Bouligand, 1960a). Presumably the gall must rupture at some time to release newly hatched larvae, though a small hole bored by one would also allow the others egress.

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## NEW AND LITTLE-KNOWN NEOTROPICAL KINNARIDAE (HOMOPTERA: FULGOROIDEA)

R. G. Fennah

*Abstract.*—The genera *Southia* and *Oeclidius* are redefined, and *Bytrois* is synonymised with the former and *Paroeclidius* is reduced to a subgenus of the latter. Two new species of *Southia* and eight new species of *Oeclidius* are described, two of the latter being wholly cavernicolous.

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The kinnarine Kinnaridae of the New World have hitherto been divided between four genera, *Oeclidius* Van Duzee, *Paroeclidius* Myers, *Southia* Kirkaldy, and *Bytrois* Fennah, the last three of which are known from only one or two species. A re-evaluation of the suitability of certain characters for generic definition has suggested that all the material studied can more appropriately be accommodated in two genera that are separable as follows.

### Key to the New World genera of Kinnarinae

1. Adults flightless; vertex at anterior margin more than twice as broad as long in middle; eyes absent; tegmina not surpassing abdomen; aedeagus bulbous, either entirely or basally ..... *Oeclidius* Van D.
- Adults not flightless; vertex at anterior margin not more than twice as broad as long in middle; eyes present; tegmina much surpassing abdomen; aedeagus bulbous basally, or otherwise ..... 2
2. Vertex with anterior margin usually distad of level of middle of eyes; lateral margins of frons sinuately incurved at union with lateral carinae of post-clypeus; rostrum with apical segment longer than subapical; tegmina with transverse veinlet between M and Cu1 at apex of basal cell; aedeagus bulbous at base, and usually with slender vertical cylindrical rod ..... *Oeclidius* Van D.
- Vertex with anterior margin not or scarcely surpassing level of middle of eyes; lateral margins of frons uniting with lateral carinae of post-clypeus in an even uninterrupted curve; rostrum with apical segment shorter than subapical; tegmina without transverse veinlet between M and Cu1 at apex of basal cell; aedeagus very broadly tubular, or with ventral half shallowly basin-like .. *Southia* Kirkaldy.

In the descriptions that follow, the length of the post-tibia is the dorsal length from the base to the base of the metatarsus, and the width is the width at the middle as seen in dorsal view.

Genus *Southia* Kirkaldy

Kirkaldy, 1904:279. Type-species, *Delphax opposita* F., 1803:84.  
*Bytrois* Fennah, 1945:450. Type-species, *Bytrois nemoralis* Fennah. New synonym.

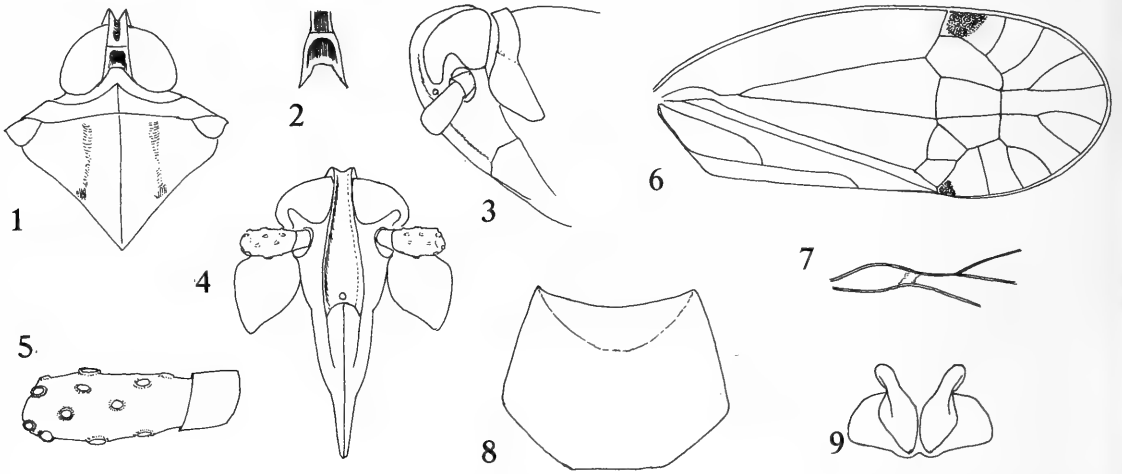
Key to species of *Southia*

- 1. Tegmina not more than 3.5 mm long; genae distinctly tumid below eye; ground color of body dark fuscous ..... 2
- Tegmina distinctly more than 3.5 mm long; genae at most only feebly tumid below eye; ground color of body yellowish, or light orange-brown ..... 4
- 2. Lateral margins of frons not elevated; lateral and median ocelli small; pronotum creamy-white except on lateral lobes .. *pisenor*, sp. n.
- Lateral margins of frons elevated; lateral and median ocelli relatively large; pronotum mostly reddish-brown or olive-brown ..... 3
- 3. Tegmina with a fuscous spot in first apical (stigmatic) cell; pronotum reddish-brown, only slightly paler along carinae and margins ..... *opposita* (F.)
- Tegmina without a fuscous spot in first apical cell; pronotum olive-brown, greenish-white along carinae and margins ..... *nemoralis* (Fennah)
- 4. Vertex broader at anterior margin than long in middle line; lateral pronotal carinae and lateral mesonotal carinae obscure or absent; pregenital sternum of female laterobasally granulate and with a pair of tumescences; third valvulae of ovipositor each with two distinct lobes distally ..... *capnorhina*, sp. n.
- Vertex not broader at anterior margin than long in middle line; lateral pronotal carinae and lateral mesonotal carinae distinct; pregenital sternum of female smooth, devoid of tumescences; third valvulae of ovipositor each with a single lobe distally ..... *iridescens* Fennah

*Southia opposita* (Fabricius)  
Figs. 1–9

*Delphax opposita* Fabricius, 1803:84.

The type, and only known specimen, of this species is a female, not a male as given by Stal (1869:95), in the Naturhistoriska Riksmuseet, Stockholm. The shrivelled genitalia (which superficially resemble the genital capsule of a male) are like those of *nemoralis*, as far as can be ascertained without dissection. The median carina of the mesonotum is fine, clearly-defined and percurrent to the apex of the mesoscutellum; the lateral carinae



Figs. 1-9. *Southia opposita* (F.): 1, head and thorax, dorsal view; 2, vertex, dorsal view; 3, head and pronotum, left side; 4, face and lateral lobes of pronotum; 5, right antenna; 6, tegmen; 7, basal cell of tegmen, showing diffuse thickening of membrane between Sc+R+M and Cu1; 8, pregenital sternum (of dried specimen); 9, third valvulae of ovipositor, posterior view (of dried specimen).

are obsolete. The pronotum is reddish-brown, and only slightly paler along the carinae and margins.

*Southia nemoralis* (Fennah), new combination

Figs. 10-14

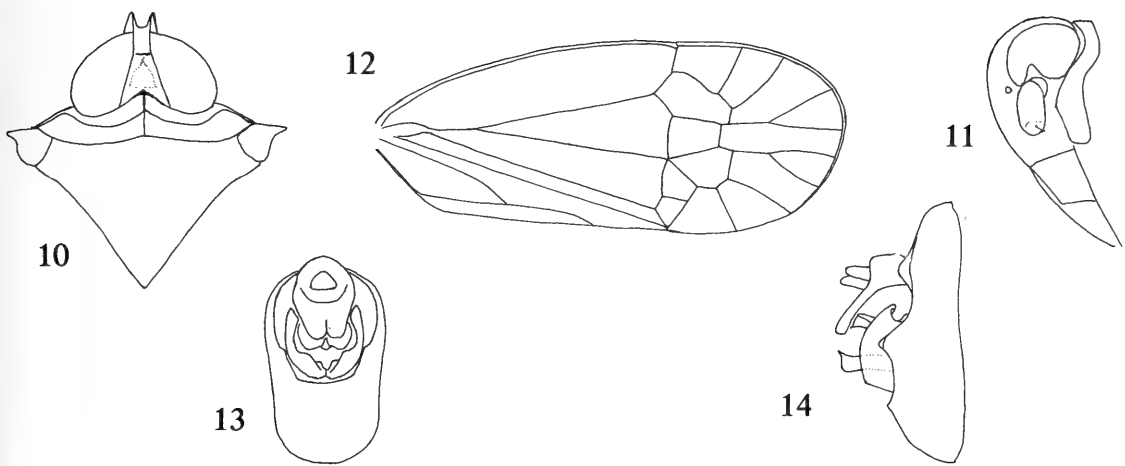
*Bytrois nemoralis* Fennah 1945:450.

In this species, the type of which is in the U.S. National Museum of Natural History, the median carina of the mesonotum is fine and moderately distinct as far as the base of the mesoscutellum, where it disappears. The pronotum in the typical (Trinidadian) population is olivaceous, and greenish-white along the carinae and margins. A female from British Guiana (Mabaruma, N. W. District, iii.1931, J. G. Myers) in the British Museum (Natural History) which appears to belong to this species has a pronotum that is reddish-brown and has margins and carinae that are stramineous.

*Southia pisenor*, new species

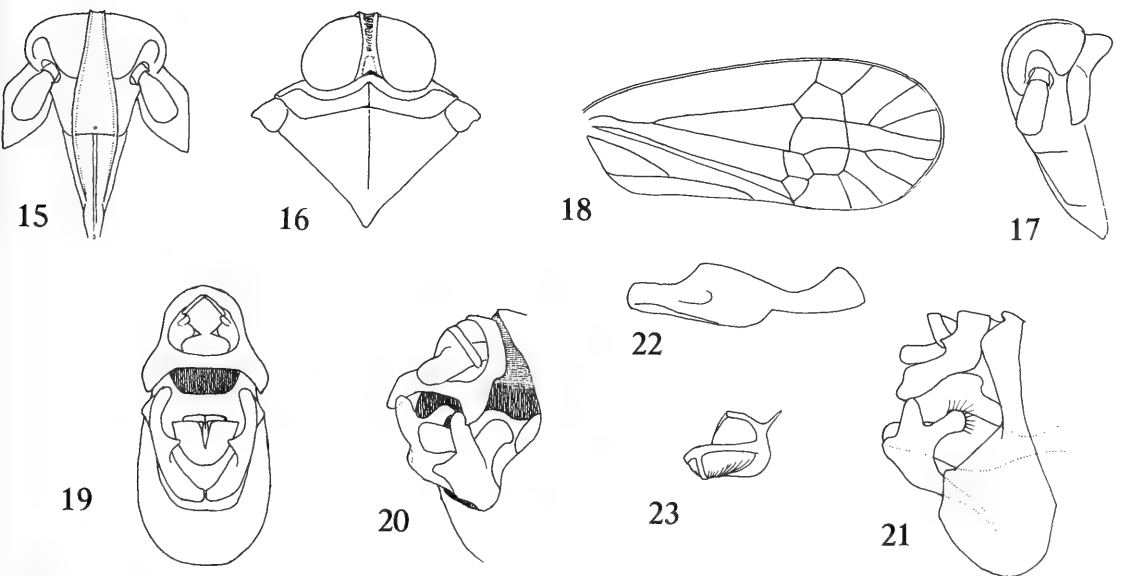
Figs. 15-23

Vertex shorter in middle line than broad at posterior margin (about 1:1.3), almost horizontal, lateral margins straight, strongly converging distad, apical margin obscure, shorter than width at base (about 1:1.5), disc rather deeply hollowed; frons in profile straight in distal two-thirds, strongly curved in basal third, smoothly rounding into vertex, in anterior view longer than broad (about 2.5:1), wider at apex than at base (about 3.5:1), basal margin transverse, lateral margins feebly sinuate, diverging distad, moder-



Figs. 10–14. *Southia nemoralis* (Fennah): **10**, head and thorax, dorsal view, **11**, head and pronotum, left side; **12**, tegmen; **13**, male genitalia, posterior view; **14**, same, right side, with part of aedeagus visible in transparency.

ately elevated in basal half, weakly so in distal half, apical margin slightly concave, median ocellus present, post-clypeus tricarinate, anteclypeus medially carinate, rostrum slightly surpassing post-trochanters; eyes and lateral ocelli present, blemma above each lateral ocellus, antennae with basal segment not as long as broad, subcylindrical, widening distad, second segment longer than first (3:1), and longer than broad (2:1). Pronotum medially car-



Figs. 15–23. *Southia pisenor*, n. sp.: **15**, face and lateral lobes of pronotum; **16**, head and thorax, dorsal view; **17**, head and pronotum, left side; **18**, tegmen; **19**, male genitalia, posterior view; **20**, same, posterolateral view from right; **21**, same, right side, with aedeagus partly seen in transparency; **22**, aedeagus, right side; **23**, apical portion of aedeagus, posteroventrolateral view from right.



inate, fine carina along anterior margin from middle to near level of lower margin of eye, then bent obliquely towards tegula; mesonotum broader than long (1.3:1), medially carinate, lateral carinae obsolete; legs moderately slender, post-tibiae longer than wide (19.6:1), with seven teeth apically, distinctly separated into two groups, basal metatarsal segment and second segment each with six teeth, tarsal claws small, each relatively stout basally. Tegmina normal, costal margin very feebly produced at base in a shallow convex lobe, wing-tucking apparatus between Cu1 and Cu2 in basal cell developed as stout triangular lobe; Sc+R+M stalk as long as basal cell, five subapical cells present and nine apical cells including stigmatic cell.

Dark fuscous; lateral margins of clypeus, frons, vertex and mesoscutellum, light reddish-brown; rostrum, all tibiae and post-tarsi, light brownish yellow; pronotum creamy-yellow, except on middle portion of lateral lobes. Tegmina hyaline, faintly yellowish, an oblique band from basal cell across clavus to posterior margin, dilute fuscous, veins reddish brown. Wings hyaline, veins fuscous.

Anal segment of male moderately long, shortly tubular in basal half, lateroapical angles each strongly produced laterocaudad and slightly deflexed, apical margin broadly transverse. Pygofer very short, dorso-lateral angles only slightly produced, lateral margins in side view concave, ventral margin rather short, slightly concave. Aedeagus scoop-shaped, with dorsal surface much shorter than ventral surface, the latter submembranous. Styles moderately long, stout, narrow basally, strongly widening beyond middle with inner margin in posterior view concave, with small lobe at middle, in profile with stout vertical process, bluntly rounded at its apex, on dorsal margin at middle.

*Male*.—Length, 2.7 mm; tegmen, 3.5 mm.

*Holotype* ♂—Panama: Patino, 19.viii.52, F. S. Blanton, in U.S. National Museum of Natural History.

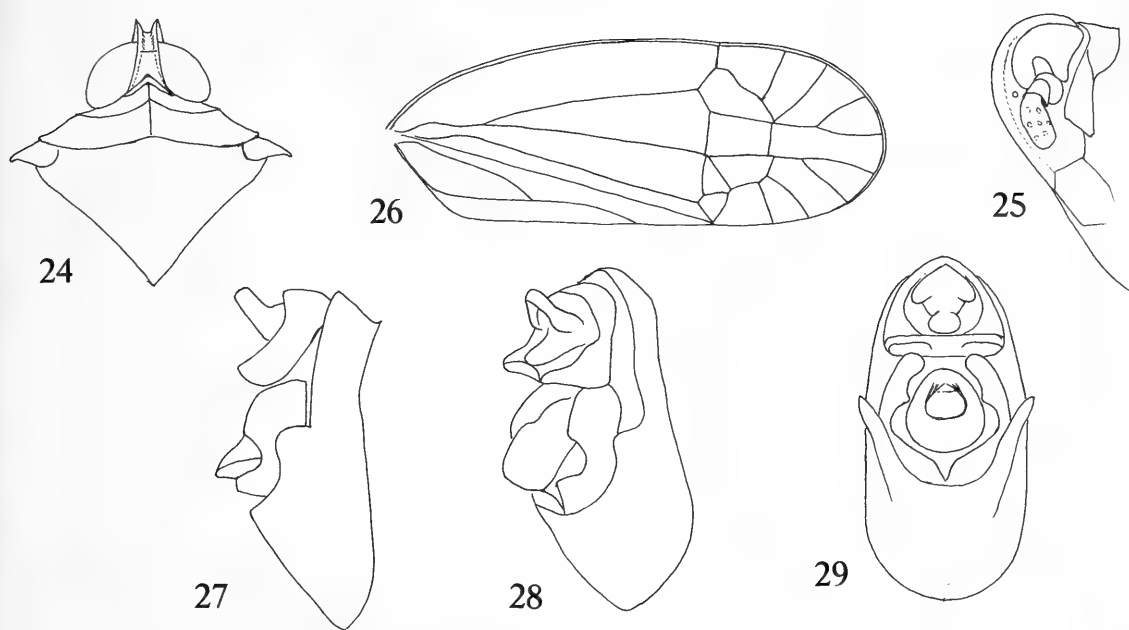
This species stands apart from others in the much less elevated lateral frontal carinae and more acutely pointed mesoscutellum, and is also well distinguished by the form of the male anal segment, aedeagus and styles. In the single specimen available, all ocelli are relatively smaller than in other species, and are deep red in color. The specific name is a classical proper name, and is a noun in apposition.

*Southia iridescens* Fennah

Figs. 24–29, 36

Fennah 1945:124.

Vertex shorter in middle line than broad at posterior margin (about 1:1.2), lateral margins straight, converging distad, apical margin transverse, shorter than width at base (about 1:1.4), disc deeply hollowed; frons in profile con-



Figs. 24–29. *Southia iridescens* Fennah: **24**, head and thorax, dorsal view; **25**, head and pronotum, left side; **26**, tegmen; **27**, male genitalia, right side; **28**, same, posterolateral view from right; **29**, same, posterior view.

vex, more strongly so in basal half, smoothly rounding into vertex, in anterior view longer than broad (measured between outer edges of lateral margins) (about 3.7:1), wider at apex than at base (about 2.0:1), basal margin slightly concave, lateral margins sinuately convex, diverging to distal fifth, foliate, apical margin transverse, median ocellus present, post-clypeus deeply inserted into frons, tricarinate, anteclypeus medially carinate, rostrum reaching to middle of abdomen; eyes and lateral ocelli present, a single obscure blemma above each lateral ocellus, antennae with basal segment slightly longer than broad (about 1.2:1), cylindrical, widening distad, second segment longer than first (2.6:1) and longer than broad (2.2:1). Pronotum medially carinate, fine carina along anterior margin from middle to near level of lower margin of eye, then bent obliquely towards tegula; mesonotum broader than long (1.6:1), finely and rather obscurely tricarinate, with carinae parallel; legs slender, post-tibiae longer than wide (24.0:1), with seven teeth apically, separated into two groups, basal metatarsal segment and second segment each with six teeth, tarsal claws small. Tegmina normal, costal margin slightly produced at base in shallow convex lobe, wing-tucking apparatus between Cu1 and Cu2 in basal cell developed as stout shallow flange; Sc+R+M stalk scarcely as long as basal cell, five subapical cells present and nine apical cells.

Light orange-brown; frons, genae, protarsi and mesotarsi, fuscous, basal segment of antennae, carinae of pronotum and femora, pale orange-yellow.

Tegmina hyaline, faintly yellowish, diffuse spot in basal half of stigmatic cell, and small suffusion just beyond claval apex, fuscous. Wings hyaline, veins fuscous.

Anal segment of male rather short, stirrup-shaped, ring-like in basal half, lateroapical angles and apical margin moderately produced caudad, apical margin transverse, thickened on each side of middle. Pygofer short, dorsolateral angles not at all produced, lateral margins produced in rounded lobe at middle, ventral margin moderately broad, slightly concave. Aedeagus relatively large, scoop-like, with lower margin strongly produced caudad, apical margin thin. Styles moderately long, stout, broad basally, narrowed medially and expanding distally, apically slightly inflected mesad. Pregenital sternum of female smooth, with surface evenly convex.

*Male*.—Length, 3.2 mm; tegmen, 4.5 mm.

*Female*.—Length, 3.1 mm; tegmen, 5.5 mm.

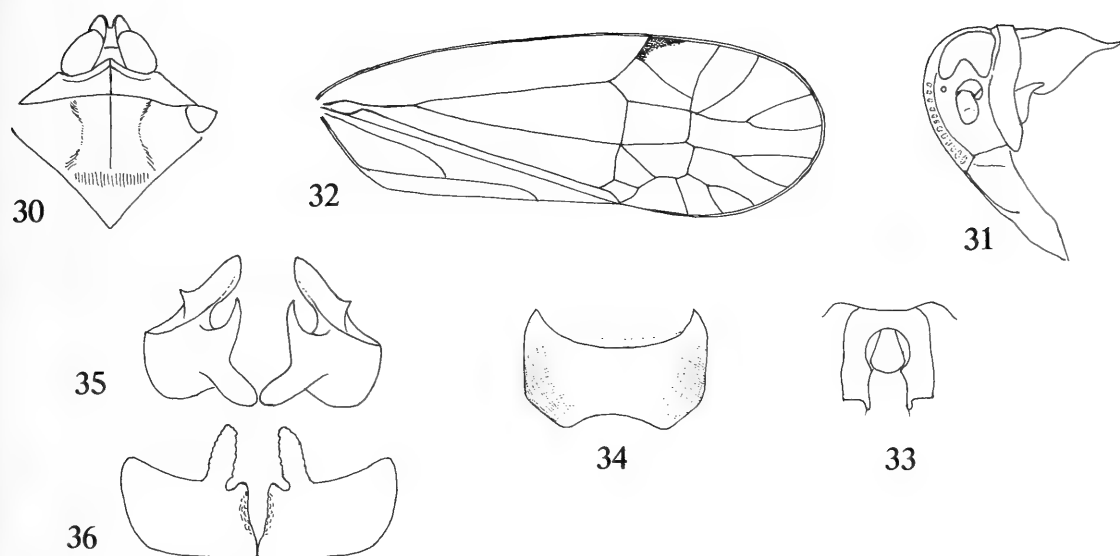
1 ♂ 2 ♀, Trinidad: undergrowth of hill forest, 18.xii.1928; 6.i.1929; Blue Basin, 4.xi.1929, J. G. Myers, in British Museum (Natural History).

This species is distinguished by its relatively large size, the profile of the head, the structure of the pygofer, aedeagus and styles and that of the pregenital sternum.

*Southia capnorhina*, new species

Figs. 30–35

Vertex shorter in middle line than broad at posterior margin (about 1:1.4), almost horizontal, lateral margins straight, markedly converging distad, apical margin transverse, shorter than width at base (about 1:1.4), disc deeply hollowed; frons in profile convex, more strongly so in basal half, curving evenly into vertex, in anterior view longer than broad (about 4:1), wider at apex than at base (about 2.7:1), basal margin transverse, lateral margins straight, diverging distad, foliate, apical margin transverse, median ocellus present, a pair of blemmata above each lateral ocellus, post-clypeus tricarinate, anteclypeus medially foliately carinate, rostrum reaching to middle of abdomen; eyes and lateral ocelli present, antennae with basal segment slightly longer than broad (1.1:1), subcylindrical, widening and slightly curved distad, second segment longer than first (2.5:1) and longer than broad (2.4:1). Pronotum medially carinate, fine carina along anterior margin from middle to near level of lower margin of eye, but becoming obsolete at this point; mesonotum a little broader than long, medially carinate except on mesoscutellum, lateral carinae obsolete; legs slender, post-tibiae longer than wide (21.3:1) with 7–8 teeth apically in two groups, basal metatarsal segment and second segment each with 6 teeth, tarsal claws small, each relatively stout basally. Tegmina normal, costal margin slightly produced ventrad in basal third in shallowly convex lobe, wing-tucking apparatus between Cu1



Figs. 30–36. *Southia capnorhina* n. sp.: 30, head and thorax, dorsal view; 31, same, left side; 32, tegmen; 33, anal segment of female, dorsal view; 34, pregenital sternum postero-ventral view, with posterior margin uppermost, and paired tumescences near anterior margin below; 35, third valvulae of ovipositor, posterior view. *Southia iridescens* Fennah. 36, third valvulae of ovipositor, posterior view, for comparison for fig. 35.

and Cu2 in basal cell developed as stout narrowly triangular lobe; Sc+R+M stalk scarcely as long as basal cell, M slightly thickened or granulate near base, five subapical cells present and ten apical cells.

Stramineous; lateral margins of frons, clypeus except laterally, post-tibiae apically and metatarsal segments apically, dark fuscous; middle part of disc of pronotum, and mesonotum, light orange-brown with faint greenish-golden sheen, metanotum, abdominal tergites in posterior half, pale yellowish brown. Tegmina milky-hyaline, faintly yellowish, suffusion narrowly overlying R-M transverse vein, Sc and basal quarter of stigmatic cell, fuscous, veins pale brownish yellow, transverse veinlets brown. Wings hyaline, veins yellowish-brown.

Anal segment of female with lateroapical angles each produced and apically truncate, in posterior view with slight papilla near each inner angle. Pregenital sternum broader than long, strongly curving dorsad at middle, with pair of weak tumescences sublaterally towards anterior margin, integument laterad of these finely granulate in oblique rows.

*Female*.—Length, 3.1 mm; tegmen, 5.0 mm.

*Holotype* ♀.—British Guiana: New River, 750 ft., 21–23.iii.1938, C. A. Hudson, in British Museum (Natural History).

*Other material*.—1 ♀, Brazil: Mato Grosso, 12°49'S–51°45'W, 9.xi.1968, W. J. Knight.

This species, which is nearest to *S. iridescens*, differs from it in the less

prominent margin around the antennal foramen, in the proportions of the vertex, the carination of the pronotum and mesonotum, the shape and sculpturing of the pregenital sternum and the shape of the third valvulae. It also differs in tegminal marking, there being no infusate spot in the membrane just distad of the claval apex. The most distinctive superficial feature is the infuscation of the lateral margins of the frons in their distal half, and of the carinae and intercarinal areas of the clypeus. The specific name, the Greek roots of which refer to this feature, is regarded as a noun in apposition.

Genus *Oeclidius* Van Duzee

Van Duzee, 1914:40. Type-species, *Oeclidius nanus* Van Duzee, 1914:40. *Paroeclidius* Myers, 1928:19. Type-species, *Paroeclidius luizi* Myers, 1928:20. Syn. n.

Key to species of *Oeclidius* of Cuba, Jamaica, and Haiti

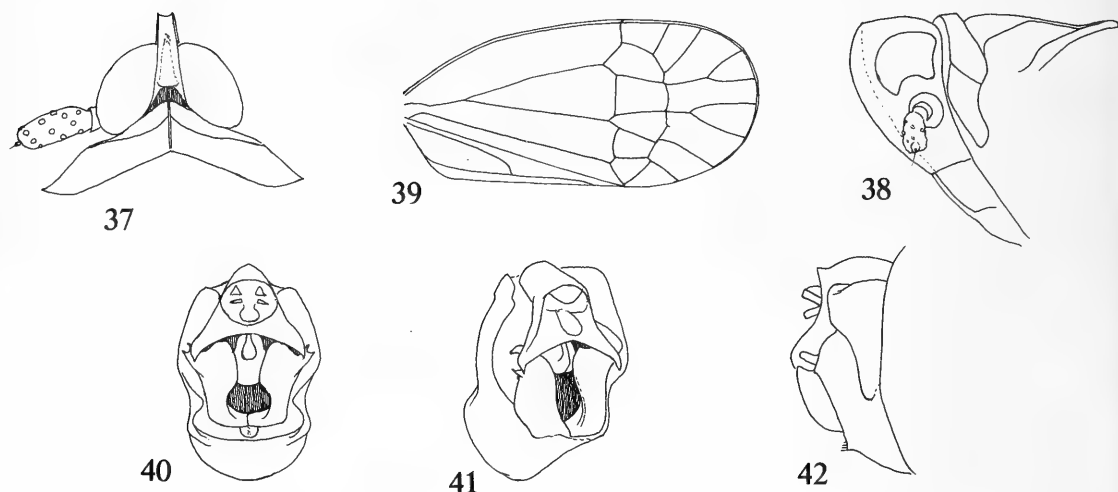
- 1. Vertex at anterior margin more than twice as broad as long in middle; eyes absent; tegmina not surpassing abdomen; integument unpigmented ..... 2
- Vertex at anterior margin not broader than long in middle; eyes present; tegmina much surpassing abdomen; integument pigmented ..... 3
- 2. Disc of frons ecarinate; mesonotum without a median carina, lateral carinae obscure ..... *minos* sp. n.
- Disc of frons with two arcuate carinae; mesonotum distinctly tricarinate ..... *antricola*, sp. n.
- 3. Vertex surpassing eyes by length of an eye; frons in profile straight, meeting vertex acutely ..... *luizi* (Myers)
- Vertex relatively shorter; frons in profile convex, more strongly so in basal half ..... 4
- 4. Mesonotum bright green, with apex of scutellum white ..... *fulgidus* (Van D.)
- Mesonotum not green, apex of scutellum not white ..... 5
- 5. Tegmina with a fuscous spot at apex of each apical vein ..... *fuscus* (Van D.)
- Tegmina without a fuscous spot at apex of each apical vein ..... 6
- 6. Vertex in profile evenly rounding into frons ..... 7
- Vertex in profile meeting frons abruptly, the point of junction distinct ..... 8
- 7. Tegmina with posterior subapical cell (Cu1a) much smaller than cell M3+4, and only about half as long ..... *trinitatis* Myers
- Tegmina with posterior subapical cell not much smaller than cell M3+4, and almost as long ..... *aboraca*, sp. n.

- 8. Tegmina with subapical cell Cu1a about twice as long as broad .. 9
  - Tegmina with subapical cell Cu1a not twice as long as broad .... 11
- 9. Post-tibiae with apical teeth evenly spaced in a single line ..... 10
  - Post-tibiae with apical teeth in two unequal groups, not in a single line ..... *pelagon*, sp. n.
- 10. Tegmina with cell Cu1a scarcely twice as long as broad, virtually touching commissural margin; no fuscous spot at stigma; median frontal ocellus absent ..... *persephone*, sp. n.
  - Tegmina with cell Cu1a more than twice as long as broad, remote from commissural margin; fuscous spot present at stigma; median frontal ocellus present ..... *hanabanillae* Myers
- 11. Apex of vertex distad of anterior margin of eyes; frons longer than broad, 5.1:1; distal venation of tegmina reddish-brown .....
  - ..... *princeps*, sp. n.
  - Apex of vertex not distad of anterior margin of eyes; frons longer than broad, 4.2:1; distal venation of tegmina dark fuscous .....
    - ..... *conopa*, sp. n.

*Oeclidius persephone*, new species  
Figs. 37–42

Vertex longer in middle line than broad at posterior margin (about 2.3:1), almost horizontal, lateral margins straight, converging distad, apical margin transverse, shorter than width at base (about 1:1.7), disc deeply hollowed longitudinally; frons in profile convex, more strongly so in basal half, meeting vertex at obtuse angle, in anterior view longer than broad (about 5.4:1), wider at apex than at base (about 2.3:1), basal margin transverse, lateral margins straight, diverging distad, foliate, apical margin transverse, median ocellus absent, post-clypeus tricarinate, anteclypeus medially carinate, rostrum reaching to middle of abdomen; eyes and lateral ocelli present, antennae with basal segment about as long as broad, subcylindrical, widening distad, second segment longer than first (3:1) and longer than broad (2:1). Pronotum medially carinate, fine carina along anterior margin from middle to near level of lower margin of eye, then bent obliquely towards tegula; mesonotum little broader than long, tricarinate, with carinae parallel; legs slender, post-tibiae longer than wide (21.9:1), with seven teeth apically, basal metatarsal segment and second segment each with seven teeth, tarsal claws small, each relatively stout basally. Tegmina normal, costal margin slightly produced at base in shallow convex lobe, wing-tucking apparatus between Cu1 and Cu2 in basal cell developed as a stout triangular lobe; Sc+R+M stalk scarcely longer than basal cell, M slightly thickened or granulate near base, five subapical cells present and nine or ten apical cells.

Creamy white; lateral margins of frons and vertex, disc of pronotum and



Figs. 37–42. *Oeclidius persephone* n. sp.: 37, head and pronotum, dorsal view; 38, head and thorax, left side; 39, tegmen; 40, Male genitalia, posterior view; 41, same, posterolateral view from left; 42, same, right side.

mesonotum, except for carinae and posterolateral margins, and legs, dilute fuscous, metanotum, abdominal tergites in posterior half, anal segment of male and inner edge of genital styles, fuscous or reddish brown, suffusion under translucent parts of abdominal terga in posterior half of abdomen, dull red. Tegmina hyaline, faintly yellowish, more distinctly so in first apical cell, veins fuscous. Wings hyaline, veins fuscous.

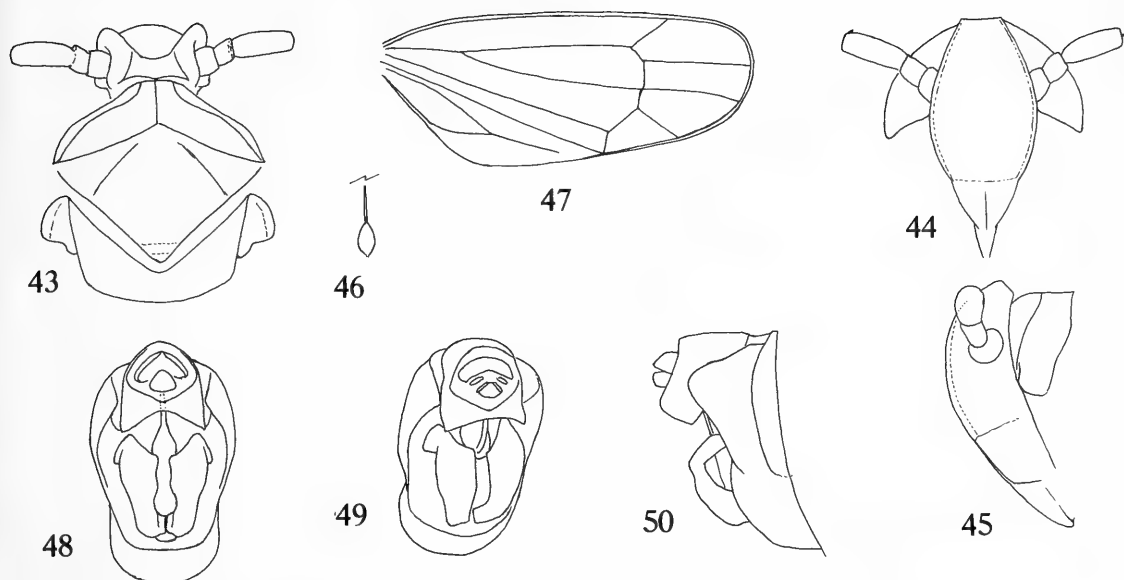
Anal segment of male moderately long, subtubular in basal half, lateroapical angles each strongly produced laterocaudad and deflexed at tip, apical margin broadly concave. Pygofer short, dorsolateral angles only slightly produced, flaring, lateral margins appearing tumid, ventral margin short, transverse or slightly concave. Aedeagus almost bulbous basally, with narrow tubular process at apex recurving dorsad. Styles moderately long, stout, narrow basally, strongly widening and twisted beyond middle with inner margin strongly sinuate, outer margin shallowly concave, apical margin tricuspidate, with two outer cusps closely approximated.

*Male*.—Length, 3.2 mm; tegmen, 3.8 mm.

*Holotype* ♂.—Jamaica: Clarendon, Portland Ridge, Portland Caves, 15.viii.74, S. Peck, in the Canadian National Insect Collection.

This species, which is almost certainly endemic, differs from the known Jamaican species of *Oeclidius*, *O. fulgidus* Van D. and *O. fuscus* Van D. in the absence of a median ocellus. From the former it also differs in the color of the mesonotum, and from the latter in the color of the frons and the lower part of the body.

The specific name is a classical proper name and is a noun in apposition.



Figs. 43–50. *Oeclidius minos*, n. sp.: 43, head and thorax, dorsal view; 44, face and lateral lobes of pronotum; 45, head and pronotum, left side; 46, third segment of antenna; 47, tegmen; 48, male genitalia, posterior view; 49, same, posterolateral view from left; 50, same, right side.

*Oeclidius minos*, new species

Figs. 43–50

Head in dorsal view broader than long, with basal part of frons amply visible. Vertex broader at hind margin than long in middle line (2.7:1). Anterior margin carinate, concave, lateral margins carinate, concave, converging distad, posterior margin transverse, sinuate, disc slightly transversely depressed; frons in middle line longer than broad, widest at about four-sevenths from base, convex transversely and in profile, basal margin shorter than apical margin, lateral margins markedly convex, subfoliately produced anterolaterad, disc smooth, ecarinate, frontoclypeal suture weakly impressed; clypeus relatively small, tricarinate, rostrum long, slender, reaching to middle of abdomen, eyes and ocelli absent, antennae with basal segment cylindrical, slightly widening distad, only slightly longer than broad, second segment cylindrical, longer than broad (about 2.4:1), rounded-truncate apically, third segment subovoid, about twice as long as broad, flagellum long, about four-fifths as long as tegmen. Pronotum relatively large, anterior margin convex, not carinate, not overlapping vertex medially, posterior margin shallowly angulately excavate, median carina distinct, lateral carinae obscure, sinuately diverging from near middle line to lateral angles; tegulae present; mesonotum broader than long (about 1.3:1), slightly convex transversely, almost ecarinate, with only feeble indication of a pair of lateral carinae that strongly diverge caudad; post-tibiae longer than wide (20:1),



laterally unarmed, apically with six teeth, basal metatarsal segment with four teeth, second segment with four teeth, tarsal claws slender, small, pulvilli small. Tegmina relatively small, reaching scarcely beyond middle of abdomen, broadest near base, tapering distad and narrowly rounding at apex, Sc+R, M and Cu1 present, each forking at transverse line of veinlets, claval suture distinct, common claval vein apparently not attaining margin. Wings each reduced to a small lobe on metapleuron.

Creamy white; all sclerites of thorax and abdomen faintly suffused yellowish brown, lateral margins of frons, median carina of pronotum, legs and male genitalia, brown. Tegmina yellowish hyaline, veins and margin of tegmen yellowish brown.

Anal segment of male short, relatively deep, lateroapical angles rectangulate. Pygofer short, dorsolateral angles a little produced, convex, slightly inflected, ventral margin entire. Aedeagus tubular, broad at base, rapidly narrowing into slender tube directed dorsad. Styles rather broad, each directed dorsad and strongly bent cephalad in distal third, widest at about two-thirds from base, rounded-truncate apically.

*Male*.—Length, 2.7 mm; tegmen, 1.7 mm.

*Holotype* ♂.—Jamaica: Clarendon, Jackson Bay, Jackson Bay Cave, 2.viii.74, S. Peck, on roots on moist clay floor, in Canadian National Insect Collection.

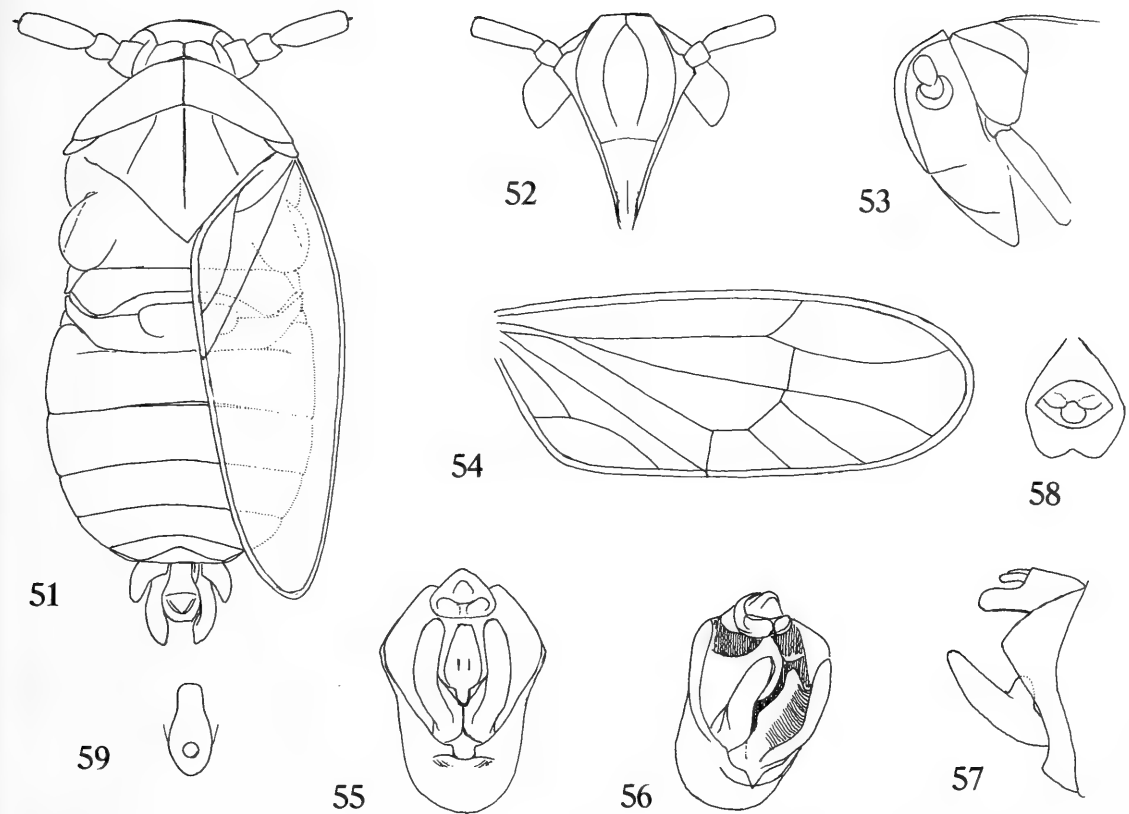
This species is distinguishable from both normally-developed species of *Oecliidius* and the wholly subterranean *O. hades* Fennah (Fennah, 1973:442) by the shape of the head and the weaker carination of the mesonotum, and from *O. hades* it differs also in the more slender legs. The male genitalia are quite distinctive, but conform in broad structure to the pattern common in the genus.

The specific name is a classical proper name, and is a noun in apposition.

*Oecliidius antricola*, new species

Figs. 51–59

Head in dorsal view broader than long, with basal part of frons amply visible. Vertex broader at hind margin than long in middle (3.5:1), anterior margin shallowly concave, weakly carinate, lateral margins carinate, straight, converging distad, posterior margin transverse, disc not depressed, medially carinate; frons longer than broad (up to 1.2:1, according to view-point), widest at middle, transversely subconvex, with median third flat, moderately convex in profile, basal margin little shorter than apical margin, lateral margins distinctly convex, pair of arcuate carinae, united little before base of frons, percurrent to apex or nearly so, not meeting distally, frontoclypeal suture slightly impressed, clypeus relatively small, laterally carinate, postclypeus obscurely medially carinate, but distinctly so at junction



Figs. 51–59. *Oeclidius antricola*, n. sp.: 51, body and right tegmen, dorsal view; 52, face and lateral lobes of pronotum; 53, head and pronotum, left side; 54, tegmen; 55, male genitalia, posterior view; 56, same, posterolateral view from left; 57, same, right side; 58, anal segment of male, posterior view; 59, aedeagus, posterior view.

with anteclypeus, which also is medially carinate, rostrum long, slender, slightly tapering near apex, reaching to basal third of abdomen; eyes and ocelli absent, antennae with basal segment barrel-shaped, slightly longer than broad, second segment cylindrical, longer than broad (3:1), rounded-truncate apically, third segment rather elongate, flagellum longer than third segment (about 2.5:1). Pronotum relatively large, anterior margin strongly carinate, broadly convex, not overlapping vertex medially, posterior margin sinuately concave, median carina weak, lateral lobes of pronotum flat; tegulae present; mesonotum broader than long (about 1.7:1), moderately convex transversely, distinctly tricarinate, with lateral carinae strongly diverging basad; post-tibiae longer than wide (21.7:1), laterally unarmed, apically with 6–7 teeth, basal metatarsal segment with five teeth, second segment with four teeth, tarsal claws slender, small, pulvillus moderately well developed. Tegmina reaching to apex of abdomen, broadest near base, tapering distad and narrowly rounding at apex, Sc+R, M and Cu1 present, each forking at transverse veinlets, position of furcation of veins rather irregular, claval suture distinct. Wings each reduced to small broadly rounded scale.

Creamy white; legs pale stramineous, carinae of head and thorax fuscous. Tegmina hyaline, pallid stramineous, veins concolorous.

Anal segment of male short, in dorsal view widening distad in basal two-thirds, then narrowing in apical third, apical margin shallowly excavate. Pygofer with dorsolateral angles convex, slightly produced, markedly flaring laterocaudad, ventral margin produced in slight lobe on each side of middle. Aedeagus short and broad, vertical, with a circular orifice in middle at widest part. Styles relatively long and broad in side view with dorsal margin deeply concave, apical margin narrowly rounded, in posterior view gradually widening distad, moderately curved, rounded apically.

*Male*.—Length, 3.0 mm; tegmen, 2.0 mm.

*Holotype* ♂.—Jamaica: Clarendon, Jackson Bay, Jackson Bay Cave, 2.viii.74, S. Peck, on roots on moist clay floor, in Canadian National Insect Collection.

*Other material*.—6 ♂, 25 nymphs of different stages, with same data as type.

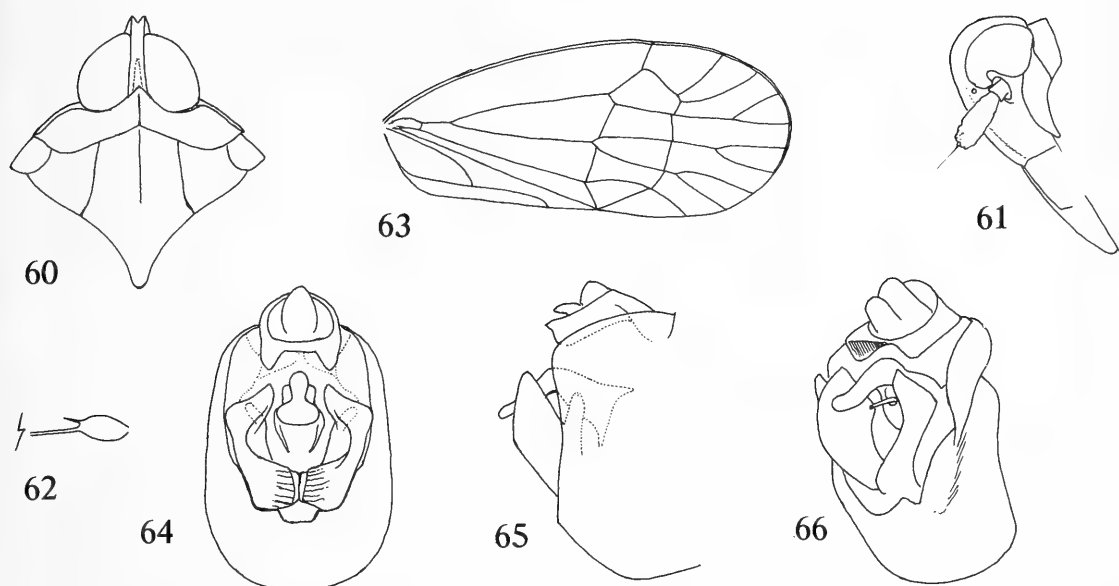
This greatly modified species can only be compared with the Mexican *O. hades* Fenn. From this it differs in the proportions of the vertex and of the second antennal segment, the shape and venation of the tegmina, and the shape of every element of the male genitalia.

The specific name is from the Latin *antrum*, cave, and suffix *-cola*, inhabitant, and is a noun in apposition.

*Oecli dius aboraca*, new species

Figs. 60–66

Vertex longer in middle line than broad at posterior margin (about 3.5:1), almost horizontal, lateral margins straight, converging distad, apical margin concave, shorter than width at base (about 1:2.0), disc deeply hollowed longitudinally; frons in profile shallowly convex, rounding smoothly into vertex, in anterior view longer than broad (about 3.5:1), wider at apex than at base (about 3.6:1), basal margin transverse, lateral margins slightly sinuate, diverging distad to one-sixth from apex, foliate, apical margin transverse, median ocellus small, postclypeus tricarinate, anteclypeus medially carinate, rostrum reaching to middle of abdomen; eyes and lateral ocelli present and pair of blemmata on each side, antennae with basal segment about as long as broad, subcylindrical, widening distad, second segment longer than first (3:1) and longer than broad (2.7:1), third segment with short arista in addition to flagellum. Pronotum medially carinate, fine carina along anterior margin from middle to near level of lower margin of eye, then bent obliquely towards tegula; mesonotum a little broader than long, tricarinate, with carinae almost parallel; legs slender, post-tibiae longer than wide (25:1), with seven teeth apically in two unequal groups, basal metatarsal



Figs. 60–66. *Oeclidius aboraca*, n. sp.: **60**, head and thorax, dorsal view; **61**, head and pronotum, left side; **62**, base of third segment of antenna; **63**, tegmen; **64**, male genitalia, posterior view; **65**, same, left side; **66**, same, posterolateral view from right.

segment and second segment each with six teeth, tarsal claws small, each relatively stout basally. Tegmina normal, costal margin slightly produced at base in shallow convex lobe, wing-tucking apparatus between Cu1 and Cu2 in basal cell developed as stout triangular lobe; Sc+R+M stalk about as long as basal cell, five subapical cells present and ten apical cells. Last subapical cell (cell Cu1a) longer than broad at base (2.7:1).

Pale yellow; lateral margins of frons and vertex very narrowly, basal segment of antennae, disc of mesonotum, except mesoscutellum, dark fuscous, fore- and middle legs striped with fuscous, abdominal terga and anal segment of male, dilute fuscous, suffusion under translucent parts of abdominal terga in posterior half of abdomen, dull red. Tegmina hyaline, faintly yellowish, veins dull yellow. Wings hyaline, veins fuscous.

Anal segment of male short, ring-like, lateroapical angles each broadly and weakly produced ventrad, apical margin transverse. Pygofer short, dorsolateral angles only slightly produced, flaring, lateral margins weakly sinuate, ventral margin short, transverse or slightly concave. Aedeagus almost bulbous basally, with stout tubular process at apex directed caudad, slender process a little below this, also directed caudad. Styles moderately long, stout, widening distad and bent mesodorsad in apical third, acute apically, moderately long vertical peg-like process on dorsal margin towards base.

*Male*.—Length, 2.8 mm; tegmen, 4.0 mm.

*Holotype* ♂.—Jamaica: Howard Gap, vii.1961, J. Maldonado Capriles, in U.S. National Museum of Natural History.

This species, which is almost certainly endemic, differs from *O. fulgidus* Van D. in the colour of the mesonotum, and from *O. fuscus* Van D. in that of the frons.

The specific name is a classical proper name, and is a noun in apposition.

*Oeclidius pelagon*, new species

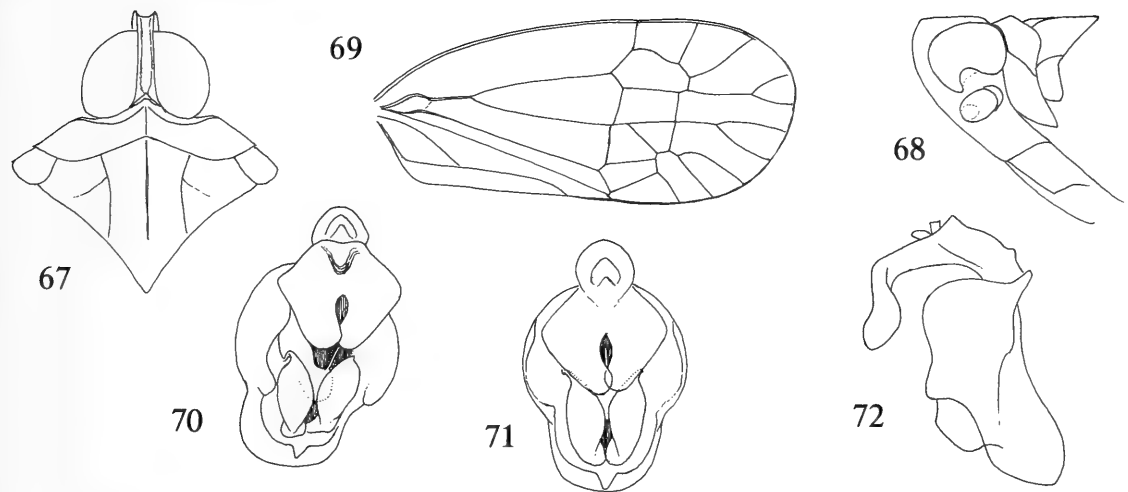
Figs. 67-72

*Oeclidius fuscus* Myers 1928:18 (misidentification).

Vertex longer in middle line than broad at posterior margin (nearly 4.0:1), almost horizontal, lateral margins almost straight, parallel, apical margin transverse, only little shorter than width at base, disc deeply hollowed longitudinally; frons in profile convex, more strongly so in basal half, meeting vertex almost rectangulately, in anterior view longer than broad (about 5.4:1), wider at apex than at base (about 2.3:1), basal margin transverse, lateral margins straight, diverging distad, foliate, apical margin transverse, median ocellus absent, post-clypeus tricarinate, anteclypeus medially carinate, rostrum reaching to middle of abdomen; eyes and lateral ocelli present, antennae with basal segment about as long as broad, subcylindrical, widening distad, second segment longer than first (3:1) and longer than broad (2:1). Pronotum medially carinate, fine carina along anterior margin from middle to near level of lower margin of eye, then bent obliquely towards tegula; mesonotum little broader than long, tricarinate, with carinae subparallel; legs slender, post-tibiae longer than wide (18:1), with seven teeth apically, basal metatarsal segment and second segment each with seven teeth, tarsal claws small, each relatively stout basally. Tegmina normal. costal margin slightly produced at base in shallow convex lobe, wing-tucking apparatus between Cu1 and Cu2 in basal cell developed as stout triangular lobe; Sc+R+M stalk scarcely longer than basal cell, five subapical cells present and nine or ten apical cells.

Dark reddish brown; lateral margins of frons and vertex, postclypeus, disc of pronotum and outer third of lateral lobes and tegulae dorsally, pale ochraceous, basal segment of rostrum, carinae and posterolateral margins of mesonotum, mesotibiae and post-tibiae, anal segment of male and third valvulae of female, pale brownish yellow, metanotum and abdominal terga in posterior half, dark fuscous. Tegmina milky hyaline, faintly yellowish, veins yellowish brown. Wings hyaline, veins fuscous.

Anal segment of male exceptionally long, subtubular in basal half, latero-apical angles each greatly dilated into broad, apically-rounded lobe that is produced ventrad and slightly overlaps its counterpart apically. Pygofer moderately long, dorsolateral angles broadly produced, lateral margins appearing tumid, ventral margin short, transverse or slightly concave, notched medially. Aedeagus almost bulbous basally, with a narrow tubular process



Figs. 67–72. *Oeclidius pelagon*, n. sp.: 67, head and thorax, dorsal view; 68, head, pronotum and mesonotum, left side; 69, tegmen; 70, male genitalia, posterolateral view from left; 71, same, posterior view; 72, same, right side.

at apex directed dorsad. Styles moderately long, stout, narrowest at base, strongly widening beyond middle with inner and outer margins sinuately convex in posterior view, apical margin strongly oblique, with outer angle acute.

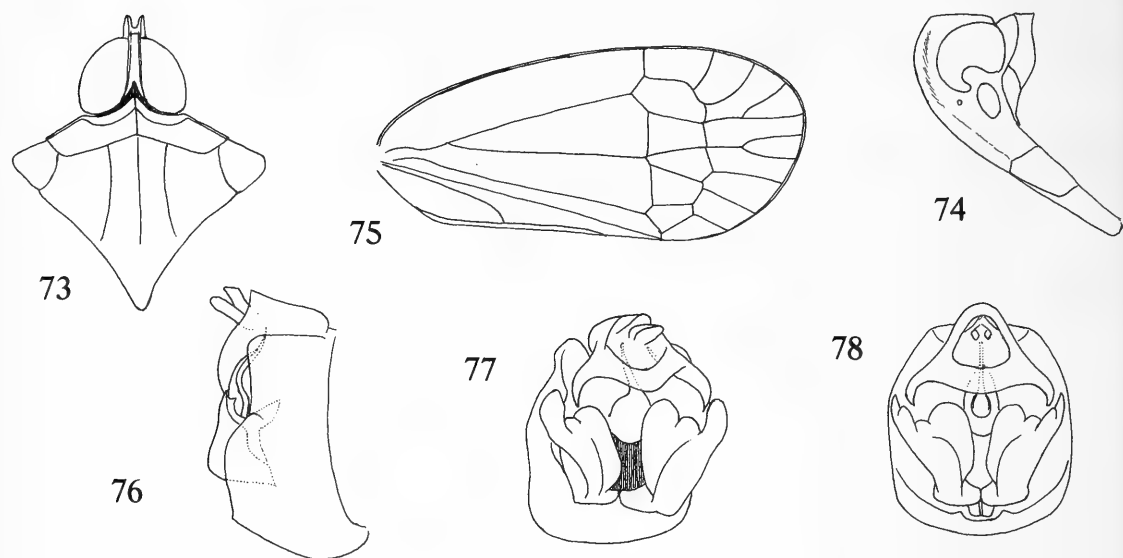
*Male*.—Length, 3.2 mm; tegmen, 3.8 mm.  
*Holotype* ♂.—Cuba: Soledad, 28.iii.1925, J. G. Myers, BM 1937-789, in British Museum (Natural History).

This species, which is almost certainly endemic, differs from the Jamaican *O. fuscus* VanD. in its smaller size, in the color of the basal antennal segment and in the absence of infuscation on the apical veinlets of the tegmen where they join the apical margin.

The specific name is a classical proper name and is a noun in apposition.

*Oeclidius princeps*, new species  
Figs. 73–78

Vertex longer in middle line than broad at posterior margin (about 3.0:1), almost horizontal, lateral margins straight, converging distad, apical margin transverse, shorter than width at base (about 1:2.4), disc deeply hollowed longitudinally; frons in profile convex, more strongly so in basal half, meeting vertex at obtuse angle, in anterior view longer than broad (about 5.0:1), wider at apex than at base (about 2.5:1), basal margin transverse, lateral margins straight or feebly concave, diverging distad, foliate, apical margin concave, median ocellus distinct, post-clypeus tricarinate, anteclypeus medially carinate, rostrum reaching to middle of abdomen; eyes and lateral ocelli present, blemmata apparently absent, antennae with basal segment

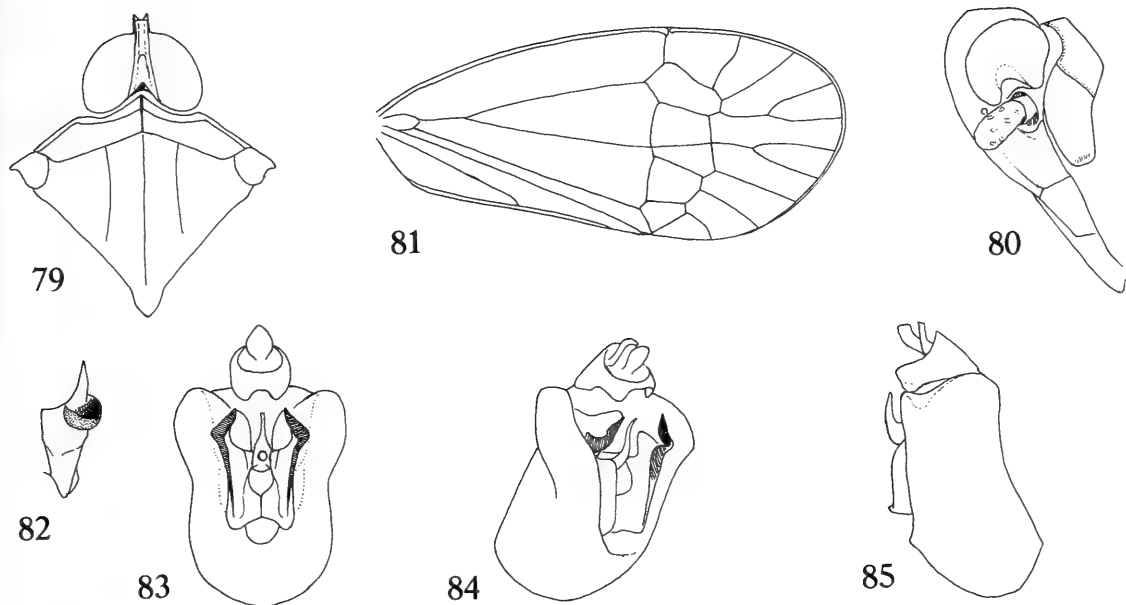


Figs. 73–78. *Oeclidius princeps*, n. sp.: 73, head and thorax, dorsal view; 74, head and pronotum, left side; 75, tegmen; 76, male genitalia, right side; 77, male genitalia, posterolateral view from left; 78, same, posterior view.

short, not as long as broad, cylindrical, second segment longer than first (3:1) and longer than broad (2:1), third segment without arista. Pronotum medially carinate, fine carina along anterior margin from middle to near level of lower margin of eye, then bent obliquely towards tegula; mesonotum little broader than long, tricarinate, with carinae parallel; legs slender, post-tibiae longer than wide (23:1), with seven teeth apically, not separated into two groups, basal metatarsal segment and second segment each with seven teeth, tarsal claws small. Tegmina normal, costal margin slightly produced ventrad at base in shallow convex lobe, wing-tucking apparatus between Cu1 and Cu2 in basal cell developed as stout triangular lobe; Sc+R+M stalk as long as basal cell, five subapical cells present and ten apical cells.

Pallid ochraceous; mesonotum, except for carinae and posterolateral margins, orange-brown, metanotum, abdominal tergites in part, reddish brown. Tegmina hyaline, faintly yellowish, veins dull yellow. Wings hyaline, veins fuscous.

Anal segment of male moderately long, subtubular in basal half, lateroapical angles each strongly produced laterocaudad and deflexed at tip, apical margin broadly concave. Pygofer short, dorsolateral angles only slightly produced, not flaring, ventral margin relatively long, transverse or slightly concave. Aedeagus almost bulbous basally, with narrow tubular process at apex recurving dorsad. Styles moderately long, stout, rather narrow basally, strongly widening beyond middle with inner margin convex, outer margin shallowly concave, subcrenulate or trilobed, with two outer lobes closely approximated.



Figs. 79–85. *Oeclidius conopa*, n. sp.: 79, head and thorax, dorsal view; 80, head and pronotum, left side; 81, tegmen; 82, right styles, dorsal view; 83, male genitalia, posterior view; 84, same, posterolateral view from left; 85, same, right side.

*Male*.—Length, 3.4 mm; tegmen, 4.5 mm.

*Holotype* ♂.—Haiti: Port au Prince, ii.1925, G. N. Wolcott, in British Museum (Natural History).

This species, which is almost certainly endemic, is apparently a Haitian counterpart of the Jamaican *O. persephone*, but differs markedly from this species in the shape of the styles.

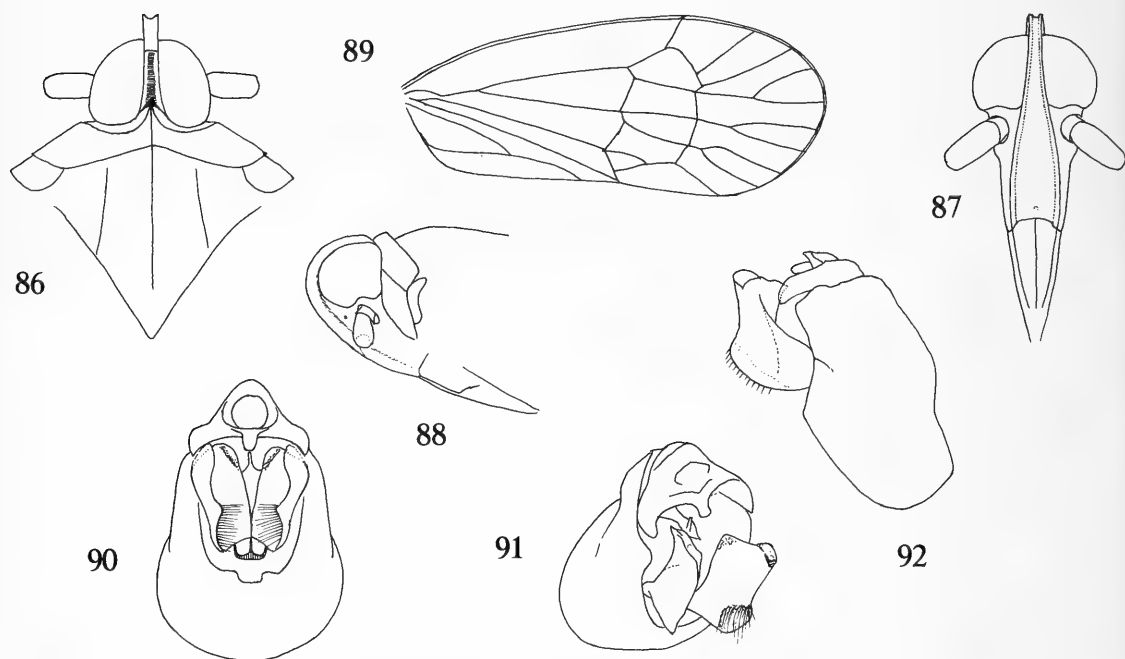
The specific name is the Latin term for prince, and is used as a noun in apposition.

*Oeclidius conopa*, new species

Figs. 79–85

Vertex longer in middle line than broad at posterior margin (about 2.1:1), almost horizontal, lateral margins straight, converging distad, apical margin transverse, shorter than width at base (about 1:2.0), disc deeply hollowed longitudinally; frons in profile convex, more strongly so in basal half, meeting vertex at an obtuse angle, in anterior view longer than broad between outer edges of lateral margins (about 4.0:1), wider at apex than at base (about 2.2:1), basal margin transverse, lateral margins shallowly sinuate, diverging to distal sixth, foliate, apical margin between carinae transverse, median ocellus present, post-clypeus tricarinate, anteclypeus medially carinate, rostrum reaching to middle of abdomen; eyes and lateral ocelli present, blemmata apparently absent, antennae with basal segment about as long





Figs. 86–92. *Oecliidius trinitatis* Myers: **86**, head and thorax, dorsal view; **87**, face; **88**, head and pronotum, left side; **89**, tegmen; **90**, male genitalia, posterior view; **91**, same, posterolateral view from left; **92**, same, right side.

as broad, subcylindrical, widening distad, second segment longer than first (3:1) and longer than broad (2:1). Pronotum medially carinate, fine carina along anterior margin from middle to near level of lower margin of eye, then bent obliquely towards tegula; mesonotum little broader than long (about 1.3:1), tricarinate, with carinae subparallel; legs slender, post-tibiae longer than wide (23:1), with seven teeth apically, not clearly separated into two groups, basal metatarsal segment and second segment each with seven teeth, tarsal claws small, each relatively stout basally. Tegmina normal, costal margin slightly produced mesad at base in a shallow convex lobe, wing-tucking apparatus between Cu1 and Cu2 in basal cell developed as stout narrowly-triangular lobe; Sc+R+M stalk about as long as basal cell, five subapical cells present and ten apical cells including stigmatic cell.

Pallid ochraceous; disc of mesonotum, except for carinae, and posterolateral margins and mesoscutellum, fuscous, more dilute in lateral fields, metanotum darker fuscous, abdominal terga 3–5 except in posterior half, and ceriferous segments 6–8 of female, fuscous. Tegmina hyaline, faintly yellowish, a little more distinctly so in stigmatic cell, veins fuscous. Wings hyaline, veins fuscous.

Anal segment of male short, almost ring-like, lateroapical angles each feebly produced ventrad in broadly rounded lobe, apical margin concave. Pygofer moderately long, dorsolateral angles only slightly produced, moderately inflected mesad, lateral margins straight, ventral margin short, trans-

verse or slightly concave. Aedeagus almost bulbous basally, with a narrow tubular process at apex recurving dorsad. Styles long, stout, broad basally, slightly narrowed at middle, where inner margin is strongly concave, outer margin straight, apical margin strongly trilobate, with outer lobe narrow, acute, directed dorsomesad and strongly pigmented.

*Male*.—Length, 2.5 mm; tegmen, 4.1 mm.

*Female*.—Length, 2.6 mm; tegmen, 5.0 mm.

Holotype ♂, Haiti: Port au Prince, vii.1961, J. Maldonado Capriles, in U.S. National Museum of Natural History.

This species, which is almost certainly endemic, differs from all known Caribbean species of *Oeclidius* in the form of the styles.

The specific name is a classical proper name and is a noun in apposition.

*Oeclidius trinitatis* (Myers)

Figs. 86–92

Myers, 1928:18.

The opportunity is taken to figure the male genitalia of this Cuban species, the type of which is in the British Museum (Natural History).

Subgenus *Paroeclidius* Myers

*Oeclidius* (*Paroeclidius*) *luizi* (Myers), new combination

*Paroeclidius luizi* Myers 1928:20.

In view of the great variability between species of *Oeclidius* in the length of the vertex and the degree of development of the mesonotal carinae, there appears to be insufficient ground for maintaining *Paroeclidius*, which includes only one species, as a separate genus on the basis of differences associated with these structures.

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# A SIPHONOSTOME COPEPOD ASSOCIATED WITH A VESTIMENTIFERAN FROM THE GALAPAGOS RIFT AND THE EAST PACIFIC RISE<sup>1</sup>

Arthur G. Humes and Masahiro Dojiri

**Abstract**—*Ceuthoecetes aliger*, new genus, new species, a siphonostome copepod belonging to the new family Dirivultidae Humes and Dojiri (in press) occurs on the tentacular crown of a large vestimentiferan living in warm water near hydrothermal vents on the Galapagos Rift and the East Pacific Rise.

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Two species of copepods are known as associates of Vestimentifera Webb, 1969, a group of tubicolous marine worms placed in the Pogonophora by Webb (1969) but among the Annelida by van der Land and Nørrevang (1977). The clausidiid *Tychidion guyanense* Humes, 1973, is associated with *Lamellibrachia luymesii* van der Land and Nørrevang, 1977, in 500 m off Guyana. *Dirivultus dentaneus* Humes and Dojiri, in press (new family Dirivultidae), occurs on the tentacular crown of *Lamellibrachia barhami* Webb, 1969, in 1125 m, off southern California. This paper includes the description of a third species of copepod, this time from the tentacular crown of a large vestimentiferan from the Galapagos Rift and the East Pacific Rise. The worms from these two areas, tentatively identified as the same species, are presently under study by Dr. Meredith L. Jones, National Museum of Natural History, Smithsonian Institution.

The vestimentiferans, living in warm water near hydrothermal vents on the Galapagos Rift (about 380 km northwest of the Galapagos and 1,000 km west of Ecuador) and the East Pacific Rise (about 250 km south of the tip of Baja California), were collected during dives by the submersible *Alvin*, operated by the Woods Hole Oceanographic Institution (see Corliss *et al.*, 1979).

Three preserved vestimentiferans were washed gently in 70 percent ethyl alcohol, making sure that the alcohol passed freely between the many lamellae on the tentacular crown. The copepods were recovered from the sediment obtained after passing the solution through a fine net (openings about 100  $\mu\text{m}$  square). The first vestimentiferan yielded 34 adults and 17

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<sup>1</sup> Contribution no. 7 of the Galapagos Rift Biology Expedition, supported by the National Science Foundation.

copepodids; the second 1 adult and 6 copepodids; and the third 2 adults and 18 copepodids. The total number was 37 adults and 41 copepodids.

The study of the copepods was aided by grant DEB 77 11879 from the National Science Foundation.

All measurements were made on specimens in lactic acid. The figures were drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. The abbreviations used are:  $A_1$  = first antenna and MXPd = maxilliped.

*Dirivultidae* Humes and Dojiri, in press

*Ceuthoecetes*, new genus

*Diagnosis*.—Siphonostomatoida, Dirivultidae. Body unmodified. Urosome 5-segmented in female, 6-segmented in male. Caudal ramus with six setae. Rostrum not well defined. First antenna 10-segmented, with aesthete on next to last segment. Prehensile second antenna with minute exopod and 2-segmented endopod with one terminal claw.

Oral cone short. Mandible a long slender blade with serrate tip, lacking palp. First maxilla with small outer lobe. Second maxilla prehensile, second segment merging with long slender claw. Maxilliped prehensile and 4-segmented with terminal claw.

Legs 1–3 with 3-segmented rami. Leg 4 with 3-segmented exopod and 2-segmented endopod. Formula for endopod 0-0; I,1. Legs 1–4 alike in both sexes.

Leg 5 sexually dimorphic, in female placed laterally with four setae on free segment and dorsal seta absent, in male placed ventrally with five setae on free segment and “dorsal” seta present. Leg 6 in female lacking identifiable setae or spines but perhaps represented by two small processes on genital area, in male with two setae on posteroventral flap on genital segment.

Other features as in species described below.

Associated with Vestimentifera.

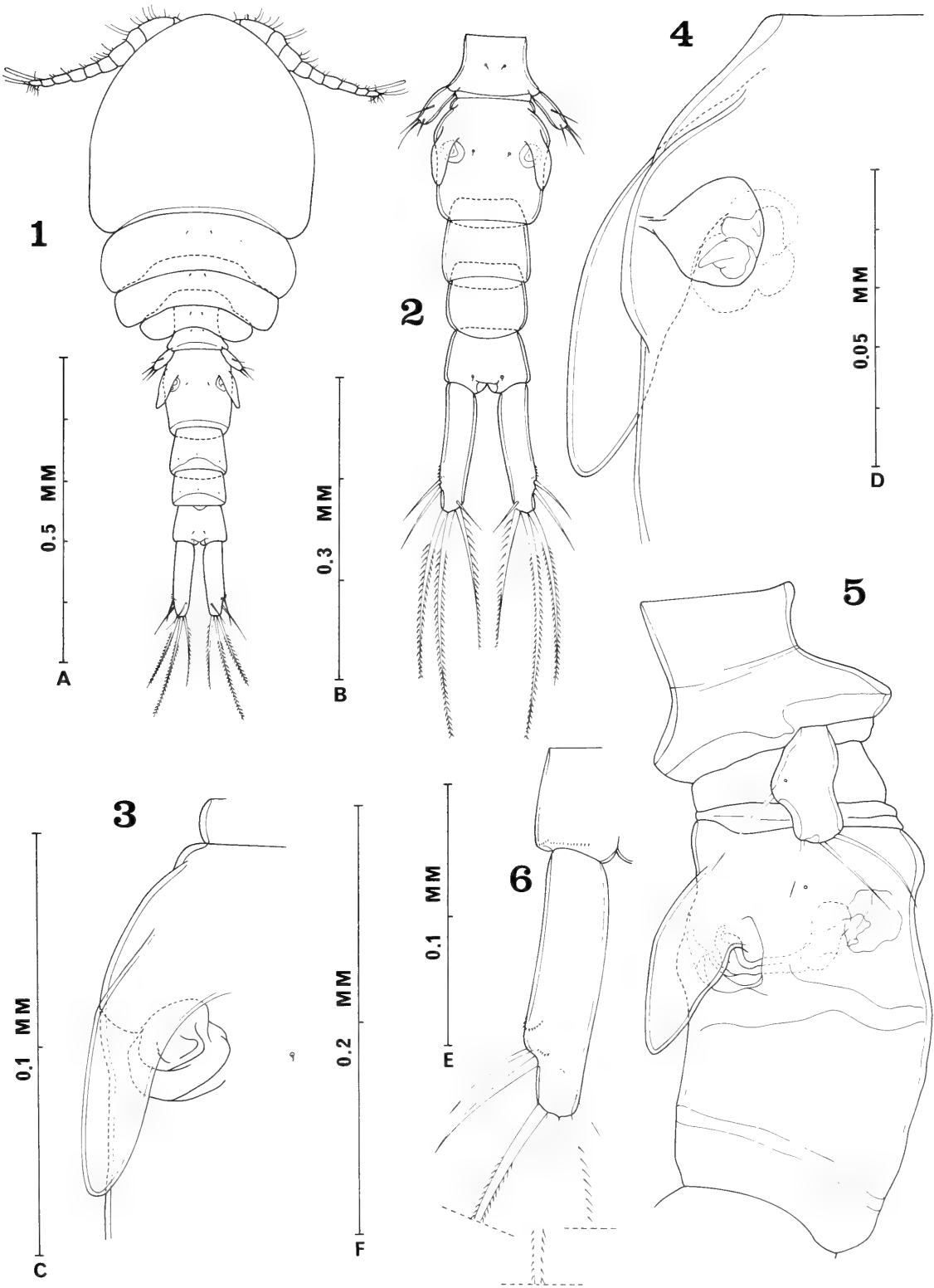
*Type-species*.—*Ceuthoecetes aliger*, new species.

*Etymology*.—The generic name is a combination of *κευθος*, the depths, and *οικητης*, an inhabitant. Gender masculine.

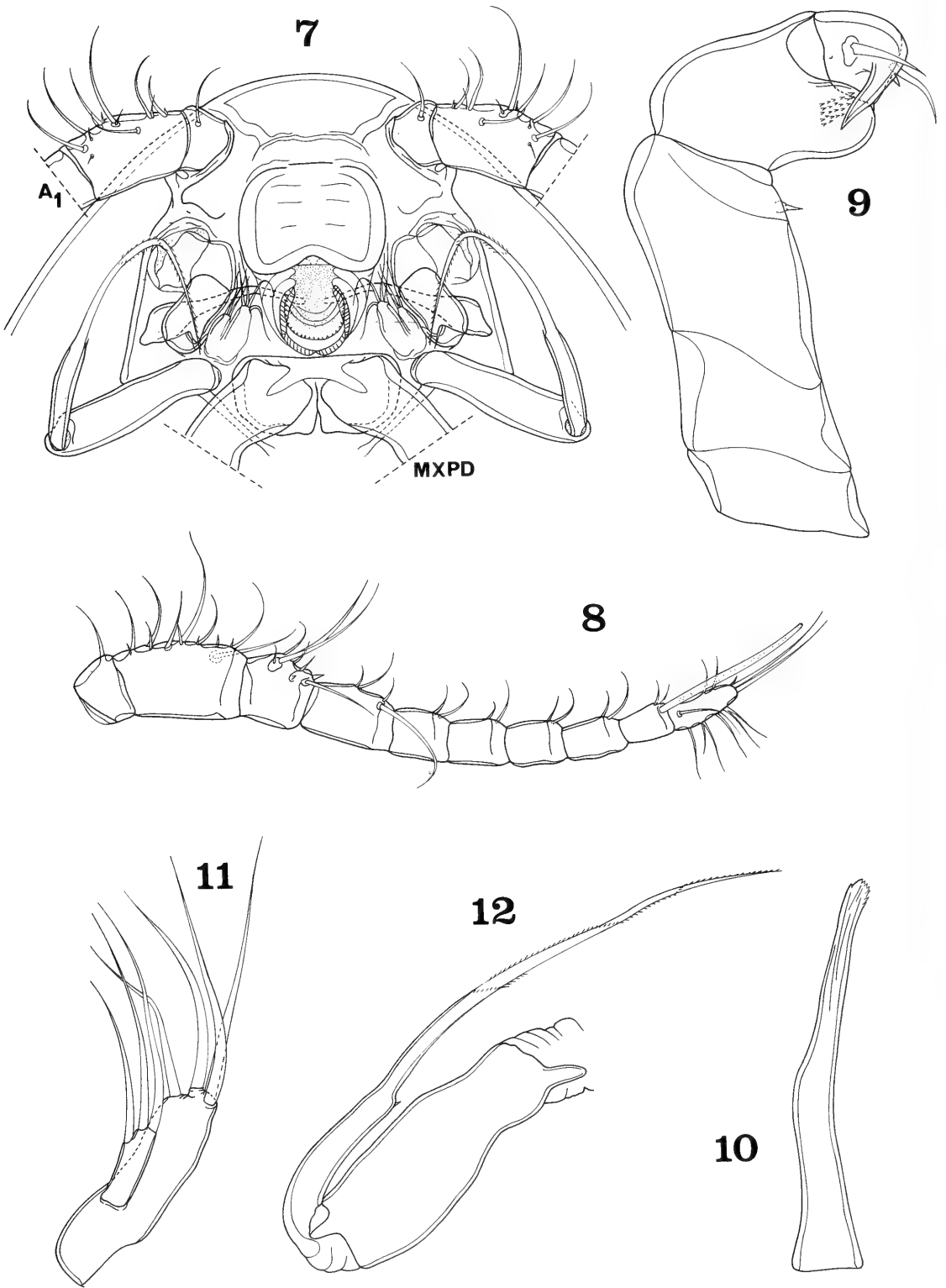
*Ceuthoecetes aliger*, new species

Figs. 1–28

*Type-material*.—8 ♀♀, 26 ♂♂, and 17 copepodids from one large vestimentiferan in 2,595 m, *Alvin* dive no. 915, East Pacific Rise, 20°51'N, 109°4.9'W, 22 April 1979. Holotype ♀, allotype, and 25 paratypes (4 ♀♀, 21 ♂♂) deposited in the National Museum of Natural History, Smithsonian



Figs. 1–6. *Ceuthoecetes aliger*, female: 1, Dorsal (A); 2, Urosome, dorsal (B); 3, Genital area, dorsal (C); 4, Genital area, ventral (D); 5, Segment of leg 5 and genital segment, lateral (E); 6, Caudal ramus, ventral (F).



Figs. 7–12. *Ceuthoecetes aliger*, female: 7, Oral area, ventral (F); 8, First antenna, ventral (F); 9, Second antenna, antero-inner (D); 10, Mandible, posterior (D); 11, First maxilla, posterolateral (C); 12, Second maxilla, posterior (C).

Institution, Washington, D.C.; the remaining paratypes (dissected) and the copepodids in the collection of the first author.

*Other specimens.*—1 ♀, 6 copepodids from part of the tentacular crown of 2 large vestimentiferans, in 2,482 m, *Alvin* dive no. 884, Garden of Eden site, Galapagos Rift (see Corliss *et al.*, 1979), 0°48.1'N, 86°7'W, 25 January 1979; 1 ♀, 1 ♂, and 18 copepodids from one entire large vestimentiferan, same locality and date.

*Female.*—Body (Fig. 1) cyclopoid. Length 1.02 mm (0.94–1.15 mm) and greatest width 0.36 mm (0.36–0.37 mm), based on 10 specimens. Segment of leg 1 not separated from cephalosome. Epimeral areas of segments of legs 1–4 rounded. Ratio of length to width of prosome 1.40:1. Ratio of length of prosome to that of urosome 1.08:1.

Segment of leg 5 (Fig. 2)  $59 \times 84 \mu\text{m}$ . Genital segment  $130 \times 111 \mu\text{m}$ , only slightly expanded laterally in anterior third where segment bears a pair of prominent digitiform dorsoposteriorly directed lobes approximately  $62 \times 16 \mu\text{m}$  (Figs. 3, 4, 5). Genital areas (Figs. 3, 4, 5) lacking identifiable setae or spines but with two small conical processes about  $5 \mu\text{m}$  and  $11 \mu\text{m}$  (Fig. 4). Three postgenital segments from anterior to posterior  $92 \times 92$ ,  $70 \times 84$ , and  $59 \times 81 \mu\text{m}$ . Anal segment with posteroventral row of small spines on each side (Fig. 6).

Caudal ramus (Fig. 6) elongate,  $122 \times 32 \mu\text{m}$ , ratio 3.81:1. Outer lateral seta  $59 \mu\text{m}$ , dorsal seta  $46 \mu\text{m}$ , outermost terminal seta  $68 \mu\text{m}$ , all smooth. Innermost terminal seta  $132 \mu\text{m}$ , with inner hairs. Two median terminal setae  $167 \mu\text{m}$  (outer) and  $232 \mu\text{m}$  (inner), both bilaterally barbed. Ventral surface of ramus near lateral seta with two rows of minute spinules.

Body surface with few small hairs (sensilla) as in Figure 1.

Egg sac unknown.

Rostral area (Fig. 7) not well defined.

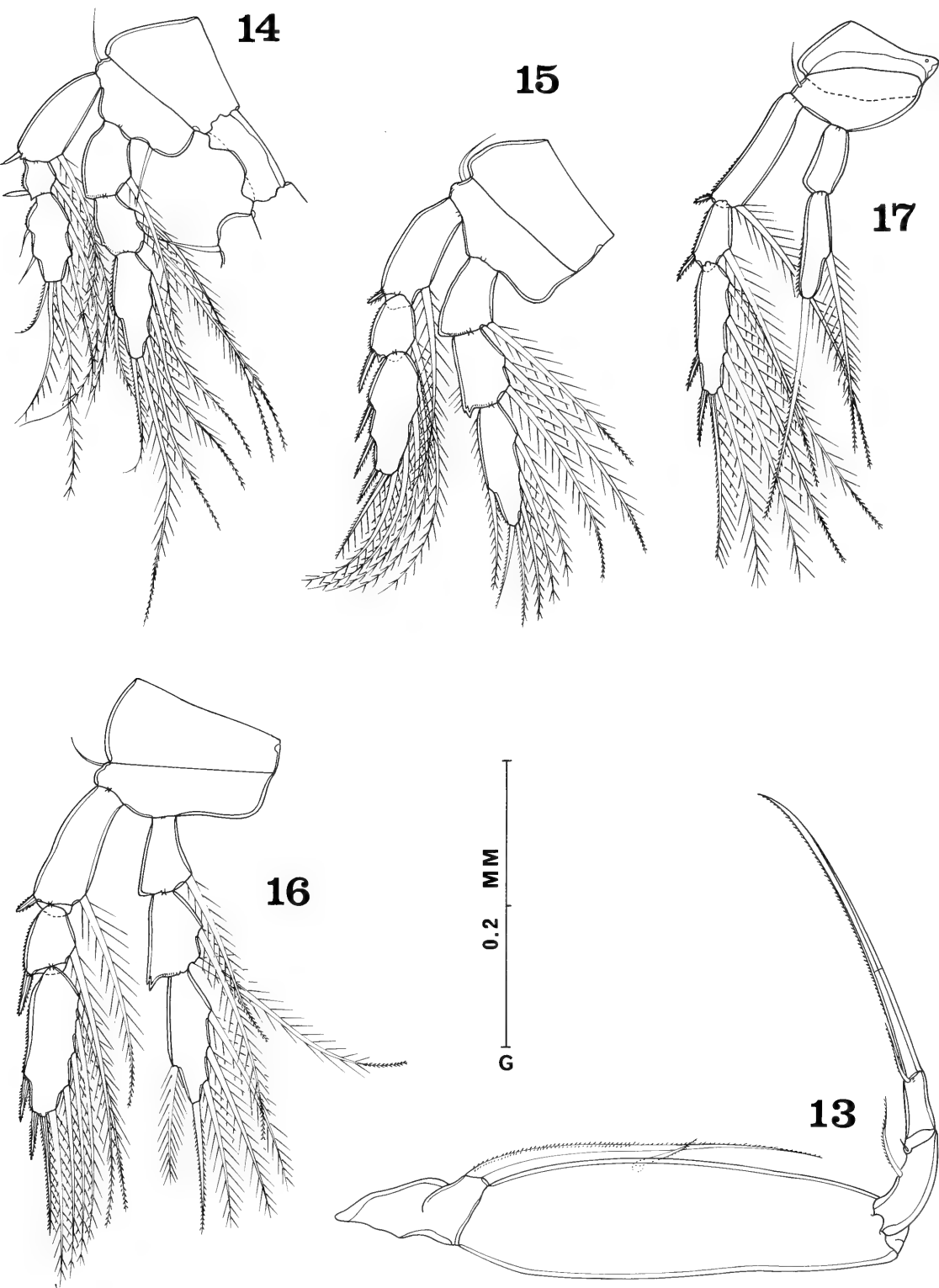
First antenna (Fig. 8) 10-segmented and  $288 \mu\text{m}$  long. Lengths of segments (measured along their posterior nonsetiferous margins): 8 ( $20 \mu\text{m}$  along anterior margin), 43, 27, 41, 27, 27, 27, 30, 22, and  $27 \mu\text{m}$  respectively. Formula for armature: 1, 13, 9, 4, 2, 2, 2, 2, 2 + 1 aesthete, and 12. All setae smooth.

Second antenna (Fig. 9) 4-segmented,  $124 \mu\text{m}$  long. Protopod 2-segmented but coxa subdivided, giving appearance of three segments. Exopod a minute process. Endopod 2-segmented, first segment slightly swollen with patch of small spines distally on antero-inner surface; second segment bearing three naked setae and a recurved claw approximately  $30 \mu\text{m}$  long.

Labrum (Fig. 7) broad with posteroventral margin weakly indented. Oral cone short with incomplete dentate inner ring (Fig. 7).

Mandible (Fig. 10) a long slender blade  $65 \mu\text{m}$  with finely serrate tip. Paragnath not seen. First maxilla (Fig. 11) with small outer lobe having three setae, large inner lobe with four setae, all setae smooth. Second max-





Figs. 13–17. *Ceuthoecetes aliger*, female: 13, Maxilliped, posterior (F); 14, Leg 1 and intercoxal plate, anterior (G); 15, Leg 2, anterior (G); 16, Leg 3, anterior (G); 17, Leg 4, anterior (G).

illa (Fig. 12) with elongate first segment  $78 \times 25 \mu\text{m}$  including proximal blunt spinelike process. Second segment merging with long slender claw, forming functional claw  $157 \mu\text{m}$  long provided distally with small spinules. Maxilliped (Fig. 13) 4-segmented. First segment small with long spinulose inner seta. Second segment elongate,  $189 \times 54 \mu\text{m}$ , with short inner seta. Third segment  $51 \mu\text{m}$  long with two very unequal setae. Fourth segment  $27 \mu\text{m}$ , with one seta and two minute spinules. Claw nearly straight,  $135 \mu\text{m}$ , obscurely subdivided and bearing short spinules along inner side.

Ventral area between maxillipeds and first pair of legs without special sclerotization.

Legs 1–4 (Figs. 14, 15, 16, 17) biramous, with all rami 3-segmented except for 2-segmented endopod of leg 4. Formula for armature as follows (Roman numerals indicating spines, Arabic numerals representing setae):

$P_1$	coxa	0–0	basis	1–1	exp	I–1; I–1; II,I,4
					enp	0–1; 0–2; 1,2,3
$P_2$	coxa	0–0	basis	1–0	exp	I–1; I–1; III,I,4
					enp	0–1; 0–2; 1,2,3
$P_3$	coxa	0–0	basis	1–0	exp	I–1; I–1; II,I,5
					enp	0–1; 0–2; 1,1,3
$P_4$	coxa	0–0	basis	1–0	exp	I–1; I–1; II,I,4
					enp	0–0; I,1

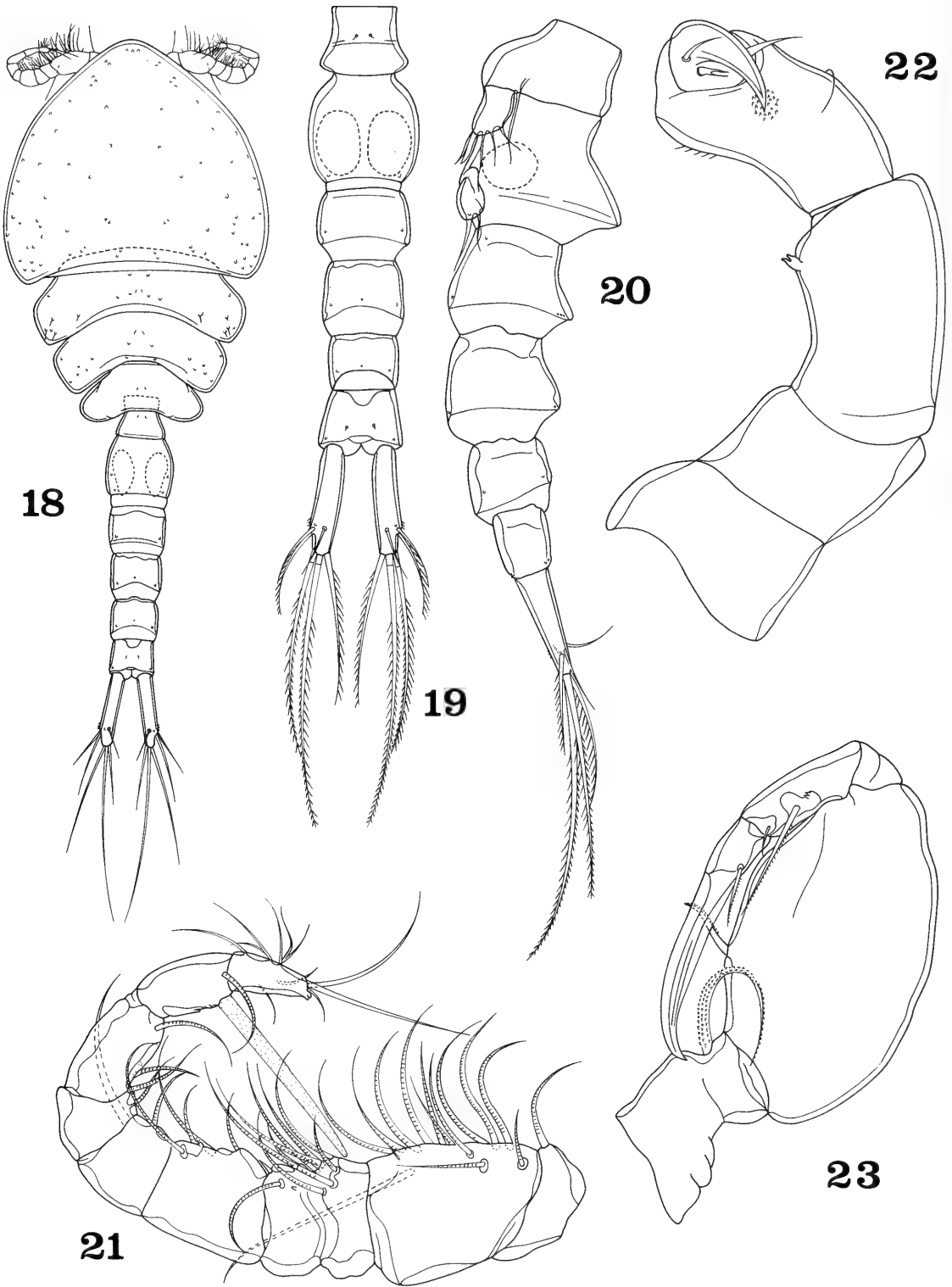
Leg 1 (Fig. 14) with intercoxal plate bearing pair of processes on ventral margin. Basis with smooth inner seta  $43 \mu\text{m}$  long. Outer spines on exopod weak and setiform. Proximal five inner setae on endopod with short spinules near tips instead of long hairs. Outer margin of first endopod segment smooth (as in legs 2–4 also). Leg 2 (Fig. 15) and leg 3 (Fig. 16) with bifurcate distal outer process on second endopod segment and with several setae showing short distal spinules as in leg 1. Leg 4 (Fig. 17) with exopod  $216 \mu\text{m}$ . Endopod with smooth unarmed first segment  $49 \times 21 \mu\text{m}$ ; second segment  $76 \times 21 \mu\text{m}$ , with terminal barbed spine  $146 \mu\text{m}$  and inner seta  $151 \mu\text{m}$ , segment with small spinules along outer margin.

Leg 5 (Fig. 5) irregular in form, unornamented, greatest dimensions  $43 \times 22 \mu\text{m}$  ( $16 \mu\text{m}$  wide in distal part), bearing four smooth setae from dorsal to ventral  $32$ ,  $22$ ,  $32$ , and  $46 \mu\text{m}$ . Dorsal seta absent.

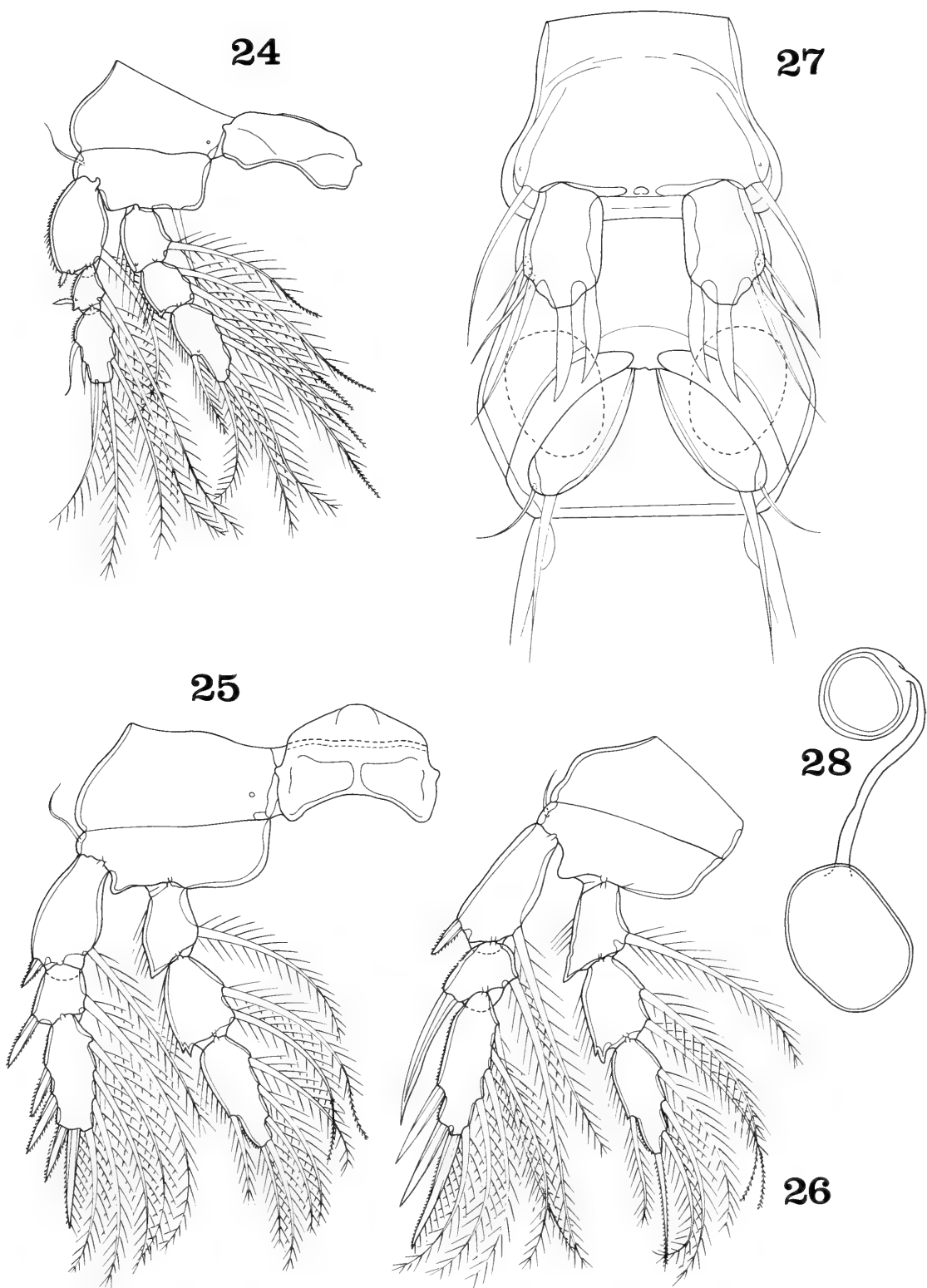
Leg 6 perhaps represented by pair of small conical processes on genital area (Fig. 4).

Color in living specimens unknown.

*Male*.—Body (Fig. 18) with cephalosome a little broader than in female. Length (excluding setae on caudal rami)  $1.14 \text{ mm}$  ( $1.03$ – $1.29 \text{ mm}$ ) and greatest width  $0.42 \text{ mm}$  ( $0.37$ – $0.45 \text{ mm}$ ), based on 10 specimens. Ratio of length to width of prosome  $1.39:1$ . Ratio of length of prosome to that of urosome  $1.31:1$ .



Figs. 18–23. *Ceuthoecetes aliger*, male: 18, Dorsal (A); 19, Urosome, dorsal (B); 20, Urosome, lateral (B); 21, First antenna, ventral (E); 22, Second antenna, antero-outer (D); 23, Maxilliped, posterior (F).



Figs. 24–28. *Ceuthoecetes aliger*, male: **24**, Leg 1 and intercoxal plate, anterior (G); **25**, Leg 2 and intercoxal plate, anterior (G); **26**, Leg 3, anterior (G); **27**, Legs 5 and 6, ventral (E); **28**, Spermatophore, as attached to genital area of female (E).

Segment of leg 5 (Fig. 19)  $81 \times 81 \mu\text{m}$ . Genital segment  $118 \times 113 \mu\text{m}$ , almost quadrate in dorsal view, but with prominent dorsal ridge in lateral view (Fig. 20). Four postgenital segments from anterior to posterior  $76 \times 86$ ,  $76 \times 81$ ,  $59 \times 70$ , and  $65 \times 70 \mu\text{m}$ .

Caudal ramus resembling that of female but a little smaller,  $113 \times 27 \mu\text{m}$ , ratio 4.2:1.

Body surface and rostrum as in female.

First antenna (Fig. 21) 10-segmented, recurved, length if straightened approximately  $318 \mu\text{m}$ . Lengths of segments (measured along their posterior nonsetiferous margins): 19 ( $27 \mu\text{m}$  along anterior margin), 41, 22, 22, 46, 30, 30, 46, 35, and  $30 \mu\text{m}$  respectively. Armature: 1, 14, 7, 4, 4, 2, 2, 2 + minute knob, 1 + aesthete + 2 small knobs, and 11 + bifid knob.

Second antenna (Fig. 22) resembling that of female but small exopod bifid. First endopod segment with inner ridge and few small outer spinules, and second endopod segment with one seta bifurcate. Labrum, oral cone, mandible, first maxilla, and second maxilla as in female. Paragnath not seen. Maxilliped (Fig. 23) with formula for armature as in female. Seta on first segment spinulose. Second segment stouter than in female. Claw  $84 \mu\text{m}$ , much shorter than in female and relatively stouter and more unguiform.

Legs 1–4 having same segmentation and formula for armature as in female. First segment of endopod in all four legs with outer hairs (these hairs absent in female). Leg 1 (Fig. 24) with inner seta on basis  $78 \mu\text{m}$  long. Leg 2 as in Figure 25. Exopod of leg 3 (Fig. 26) with outer spines 30, 103, 59, 65, and  $89 \mu\text{m}$  from proximal to distal. (In female these spines 13, 28, 27, 29, and  $82 \mu\text{m}$ ). Leg 4 as in female.

Leg 5 (Fig. 27) placed ventrally. Free segment without fine ornamentation,  $43 \times 32 \mu\text{m}$ , with five smooth setae, two inner setae broad and  $34 \mu\text{m}$  long, three outer setae slender, from outer to inner 31, 40, and  $61 \mu\text{m}$ . Seta near insertion of free segment (corresponding to usual dorsal seta, but here moved ventrally)  $78 \mu\text{m}$ .

Leg 6 (Fig. 27) a posteroventral flap on genital segment bearing two unequal smooth setae  $51 \mu\text{m}$  and  $70 \mu\text{m}$ .

Spermatophore (Fig. 28) oval,  $57 \times 41 \mu\text{m}$ , with long neck.

Color in living specimens unknown.

*Etymology*.—The specific name *aliger*, Latin meaning winged, alludes to the pair of winglike lobes on the genital segment of the female.

*Remarks*.—*Ceuthoecetes aliger*, new genus, new species, appears to be related to *Dirivultus dentaneus* Humes and Dojiri, in press, described from the vestimentiferan *Lamellibrachia barhami* Webb, 1969. The nature of the first maxilla, the prehensile character of the second maxilla, and the segmentation and armature of legs 1–4 provide evidence for this affinity. Furthermore, the general appearance of the mandible, a very conservative appendage, reflects this presumed relationship.

There are, however, fundamental differences between *Dirivultus denta-*

Table 1.—Comparison between *Dirivultus dentaneus* Humes and Dojiri, in press, and *Ceuthoecetes aliger*, new genus, new species.

	<i>Dirivultus</i>	<i>Ceuthoecetes</i>
First antenna		
Female	13-segmented	10-segmented
Male	12-segmented	10-segmented
Exopod of second antenna	1-segmented	Small process
Third segment of exopod of leg 3	III,I,5	II,I,5
Leg 5		
Female	Minute free segment with 1 seta	Large free segment with 4 setae
Male	Distinct free segment with 2 setae	Free segment with 5 setae

*neus* and *Ceuthoecetes aliger* (Table 1). Although the differences which exist between the two species concerning the first antenna and leg 5 are thought to be important, we believe at this time that *Ceuthoecetes* can be accommodated within the family Dirivultidae.

The two collections of *Ceuthoecetes aliger* are separated by about 3,700 km. This suggests that other populations are likely to be discovered along the intervening oceanic ridge system as other vent communities are studied.

Acknowledgments

We wish to thank Dr. J. Frederick Grassle of the Woods Hole Oceanographic Institution for allowing us to examine the vestimentiferans from the *Alvin* dives and for helpful suggestions during the preparation of this paper.

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## A NEW SPECIES OF *SCLEROBREGMA* (POLYCHAETA: SCALIBREGMATIDAE<sup>1</sup>) FROM OFF THE SOUTHEASTERN UNITED STATES

Rodney D. Bertelsen and Donald P. Weston

**Abstract.**—*Sclerobregma stenocerum*, a new polychaete species of the family Scalibregmatidae, is described from the continental shelf from Cape Lookout, North Carolina to Daytona Beach, Florida. The placement of *S. stenocerum* in the genus *Sclerobregma* and its affinity with the only other member of the genus, *S. branchiatum*, are discussed.

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The scalibregmid genus *Sclerobregma* previously included only *Sclerobregma branchiatum* Hartman, 1965, as *S. branchiata*. This species has been collected at slope and abyssal depths (400 to 2,500 m) off New England.

During two recent studies, a new species of *Sclerobregma* was collected at shelf depths throughout the South Atlantic Bight (Cape Hatteras to Cape Canaveral). As part of a U.S. Bureau of Land Management sponsored study, Texas Instruments, Inc. sampled the benthos of seven cross-shelf transects from Cape Fear, North Carolina to Daytona Beach, Florida. Samples were taken seasonally from February to November, 1977 using a 0.06 m<sup>2</sup> box corer. Forty-six specimens of this new *Sclerobregma* species were collected at locations indicated in Figure 1.

An additional specimen was found off Cape Lookout, North Carolina during a cooperative University of Wisconsin-Virginia Institute of Marine Science study of continental shelf benthos. Samples were taken seasonally from May, 1977 through January, 1978 in an area extending from northeast of Oregon Inlet to east of Cape Lookout, using a 0.1 m<sup>2</sup> Smith MacIntyre grab.

### *Sclerobregma stenocerum*, new species

Figs. 2-3

**Holotype.**—ENE of Daytona Beach, Florida; 29°34'N, 80°22'W; 44 m; Sta. 899-1 (7D); 2 September 1977; USNM 58955.

**Paratypes.**—1 specimen; NE of Jacksonville, Florida; 31°03'N, 80°26'W; 34 m; Sta. 230-1 (5E); 26 February 1977; USNM 58956.

1 specimen; E of Jacksonville, Florida; 30°23'N, 80°36'W; 35 m; Sta. 262-2 (6D); 1 March 1977; USNM 58957.

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<sup>1</sup> The Greek word *bregma* has as its stem *bregmat-*. Therefore, the family name should be Scalibregmatidae (G. Steyskal, pers. comm.)

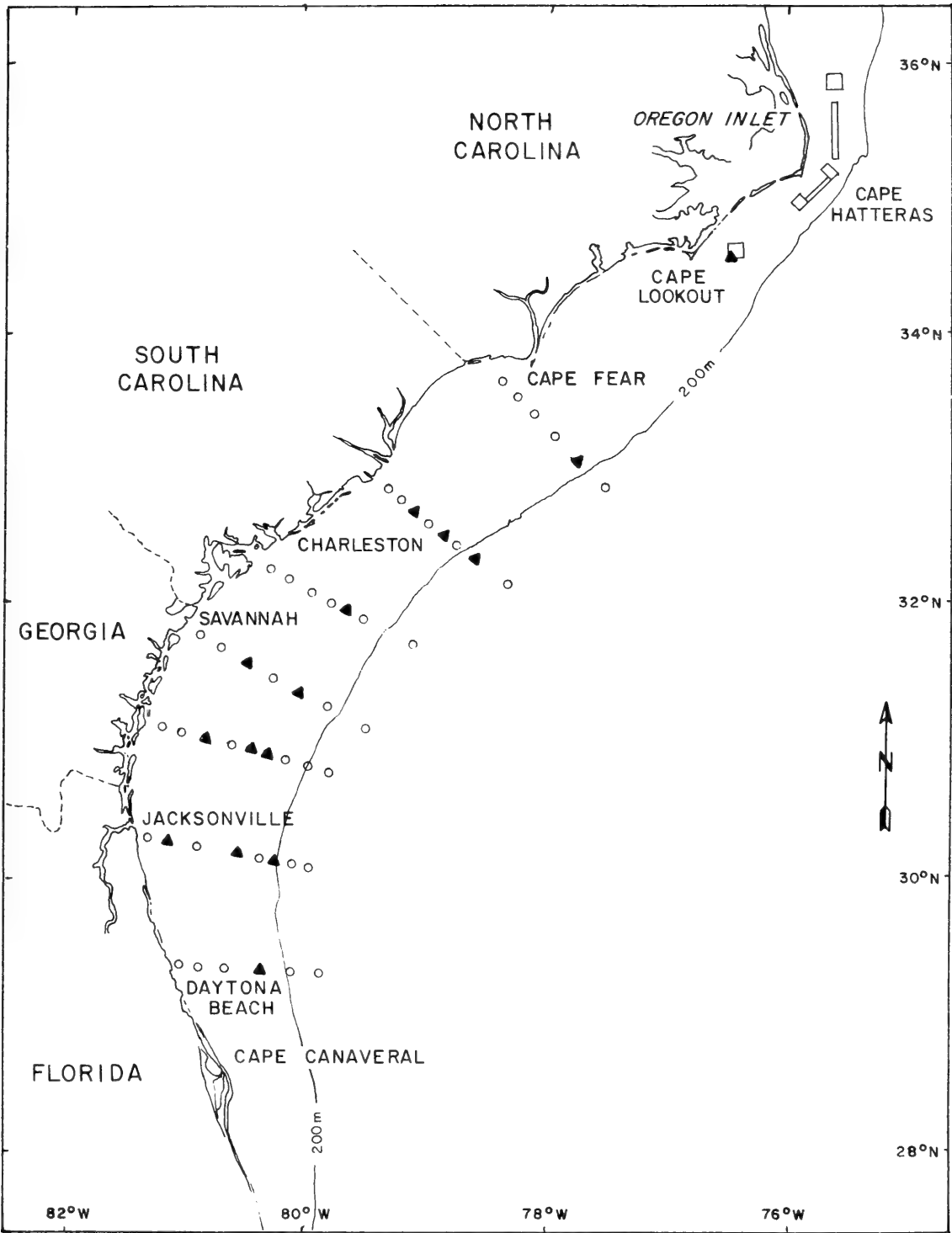


Fig. 1. Map of the South Atlantic Bight of the eastern United States showing sampling locations. Texas Instruments' stations indicated by small circles; Univ. of Wisconsin–Virginia Institute of Marine Science collection areas within open blocks. *Sclerobregma stenocerum* collection sites shown by darkened triangles.



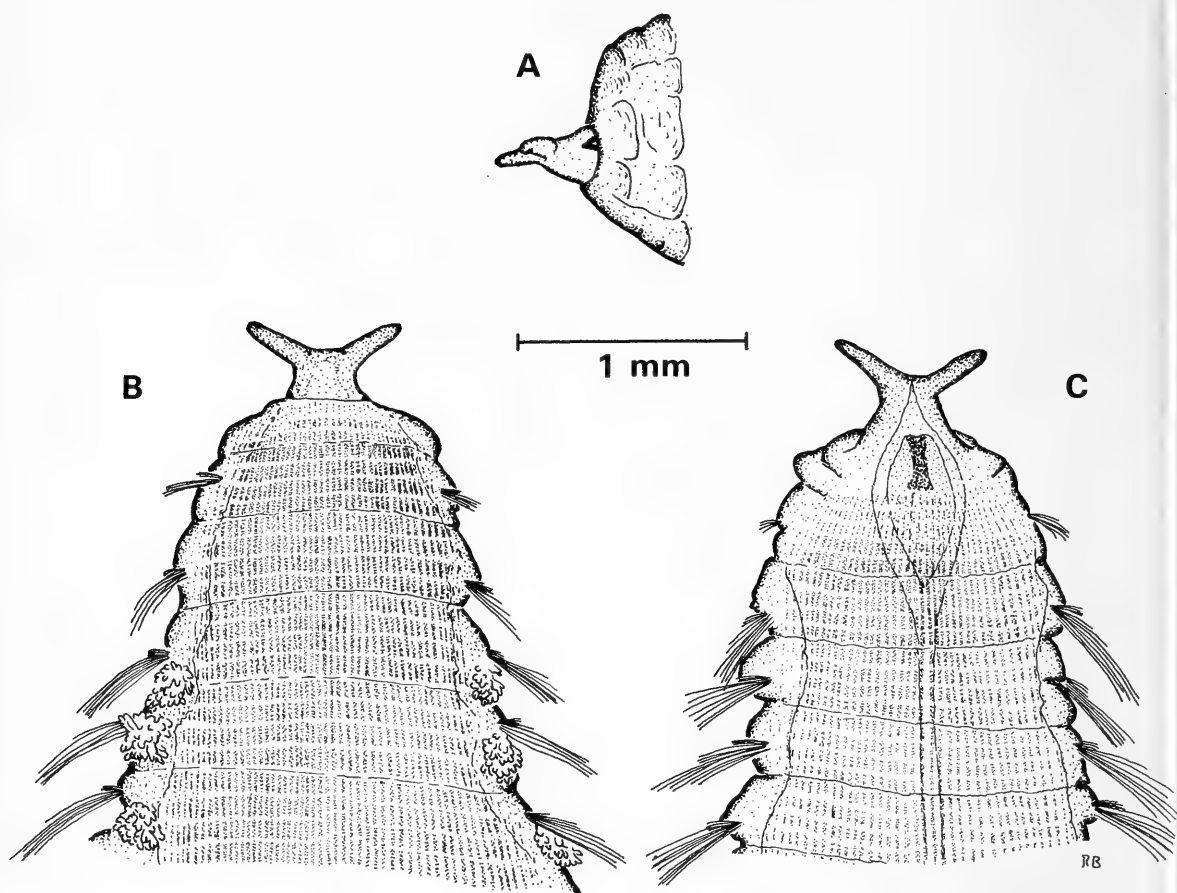


Fig. 2. *Sclerobregma stenocerum*: A, Prostomium, lateral view; B, Anterior end, dorsal view; C, Anterior end, ventral view.

1 specimen; E of Charleston, South Carolina; 32°40'N, 78°47'W; 37 m; Sta. 488-4 (2E); 13 May 1977; USNM 58958.

1 specimen; E of Cape Lookout, North Carolina; 34°34.5'N, 76°13.1'W; 38 m; Sta. 002-1; 31 May 1977; USNM 58959.

**Description.**—Holotype 8.3 mm in length, 1.2 mm in width, with 46 segments. Other specimens up to 23.1 mm long, 2.8 mm wide, with up to 49 segments. Body inflated anteriorly between setigers 6 and 17. Posterior cylindrical and slender. Segmental divisions obscured by transverse annulations and longitudinal striations (Fig. 2b, c).

Prostomium (Fig. 2a–c) T-shaped with long, slender frontal horns. Single pair of posterolateral eyes present on prostomium. Each eye V-shaped with points directed anteriorly (Fig. 2a). Eyes partly hidden by buccal segment in some specimens. Nuchal organs branched, originating at posterolateral margins of prostomium. Proboscis a soft, eversible pouch. Nuchal organs and proboscis generally retracted in preserved material. Buccal segment achaetous and apodous.

Branchiae 3 pairs; inserted posterior to notopodia of setigers 3–5 (Figs.

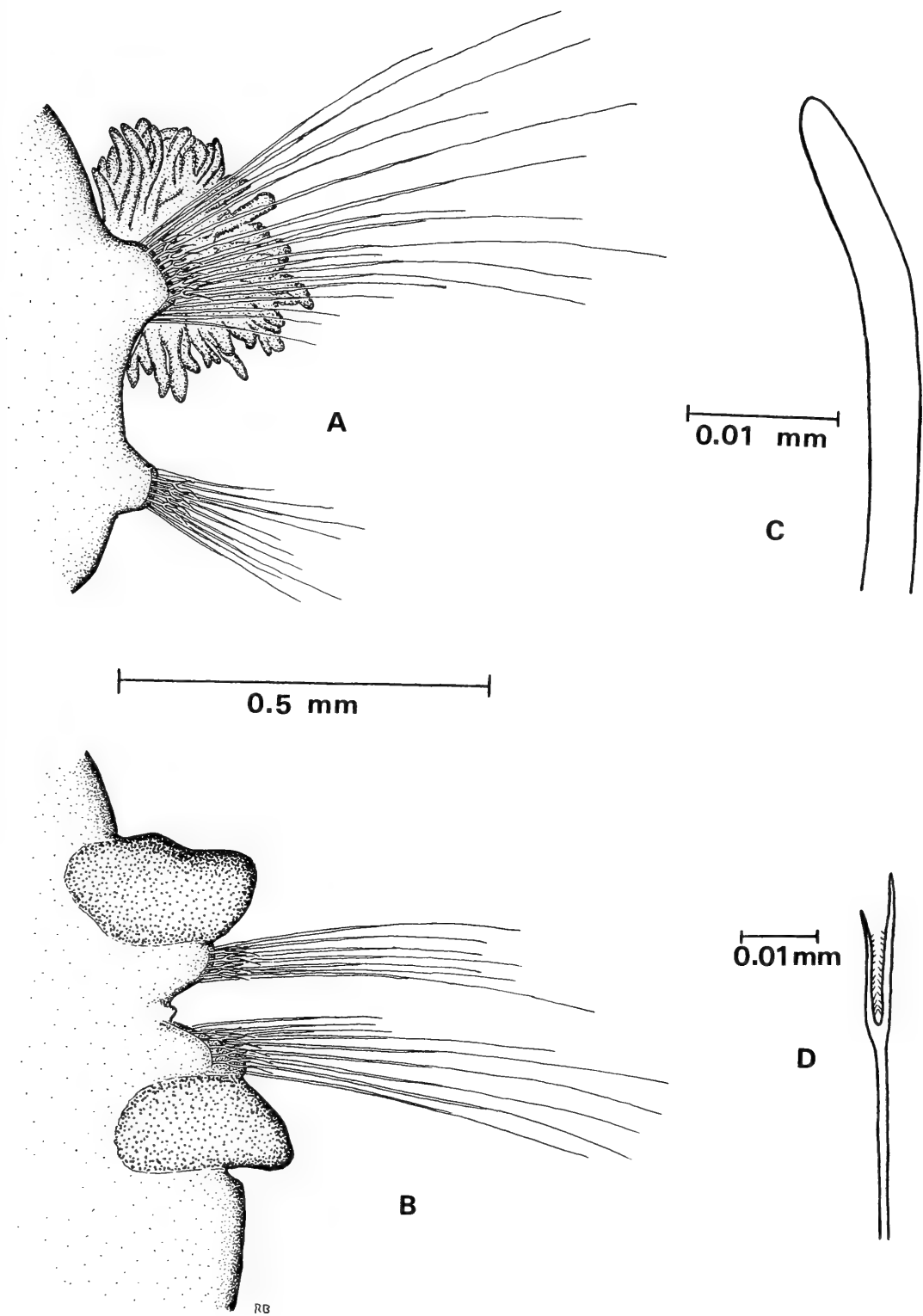


Fig. 3. *Sclerobregma stenocerum*: A, Fourth parapodium, anterior view; B, Posterior parapodium, anterior view; C, Acicular seta from anterior setiger; D, Furcate seta.

Table 1.—Distinguishing features of *Sclerobregma branchiatum* and *Sclerobregma stenocerum*.

	<i>Sclerobregma branchiatum</i>	<i>Sclerobregma stenocerum</i>
Eyes	Absent	Present
Frontal horns	Short	Elongate
Acicular setae	Long, pointed, hirsute	Very short, blunt, smooth
Branchiae	4 pairs (setigers 2–5)	3 pairs (setigers 3–5)
Ventral cirri	Some with slender, pale process at tip	Without terminal process

2b, 3a). Branchiae basically pinnate in form; each pinna with additional bifurcations.

Anterior 15 setigers with reduced parapodial lobes, lacking both dorsal and ventral cirri (Fig. 3a). Middle and posterior parapodia with inflated dorsal and ventral cirri, and small, rounded interramal organs (Fig. 3b). Cirri becoming more elongate in far posterior setigers. Both dorsal and ventral cirri usually retain reddish-brown pigmentation in alcohol.

Setae of 3 types: 1) smooth capillaries in both fascicles of all setigers; 2) short, curved, blunt acicula (Fig. 3c) in both rami of first 2–3 setigers (2–6 acicula per fascicle); 3) furcate setae (Fig. 3d) in both rami of all setigers from the third. Tines of furcate setae of unequal length and spinous along inner margins. Up to 14 furcate setae per fascicle, inserted in row anterior to capillary setae.

Ventral and ventrolateral anal cirri present; exact number indeterminable as cirri are easily detached. Number of anal cirri ranging from 0–3 on specimens examined.

*Distribution*.—Continental shelf, North Carolina to Florida; 17 to 218 m.

*Etymology*.—*Steno*, Greek for narrow; *Keras*, Greek for horn; referring to the long, narrow frontal horns on the prostomium.

Discussion

Following Ashworth (1901) and Kudenov and Blake (1978), *Sclerobregma stenocerum* is referable to the genus *Sclerobregma* on the basis of the ar-enicoliform body and the presence of dorsal and ventral cirri, acicular setae and branchiae. *S. stenocerum* differs from the generic description (Hartman, 1965) in that eyes are present. While the presence or absence of eyes is a valid specific character, their presence in *S. stenocerum* is insufficient justification to exclude it from the genus (J. Kudenov, pers. comm.). *S. stenocerum* may be readily distinguished from *S. branchiatum* by the characteristics given in Table 1.

Examination of the type-material of *Sclerobregma branchiatum*, provided

by the Allan Hancock Foundation, revealed two errors in the original description. Hartman (1965; p. 185) stated that the “upper cirri are longest, terminating in slender pale tips” (see also Hartman’s Plate 42, Fig. C). In the type-material, the ventral, rather than the dorsal cirri, bear slender, pale tips. Only the six anteriormost ventral cirri have this terminal structure, while the remaining ventral cirri and all dorsal cirri are blunt and inflated as in *S. stenocerum*.

Secondly, Hartman (1965; Plate 42, Fig. C) illustrated a small cirrus-like projection beneath the “neuropodia” (actually the notopodia). Though not discussed in the text, the figure caption refers to this structure as a ventral cirrus. The structure could not be found on the holotype (AHF Poly 0484) or the 17 paratypes (AHF Poly 0485) examined and is presumed to be an error in the figure.

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## TWO NEW SPECIES OF *CENTROLENELLA* FROM BOLIVIA (ANURA: CENTROLENIDAE)

David C. Cannatella

*Abstract.*—Two new species of glass-frogs, *Centrolenella bejaranoi* and *C. bergeri*, are described from the cloud forest of the Amazonian slopes of Bolivia. One species is allied to the *C. fleischmanni* group; the other is apparently a member of the *C. prosoblepon* group. This is the first record of the family Centrolenidae from Bolivia.

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A recent checklist (Duellman, 1977) of the centrolenid frogs shows that they are present in most countries in South America; notable exceptions are Chile, Paraguay, Uruguay, and Bolivia. The apparent absence of these glass-frogs from Bolivia is surprising, because the *yungas* region of the Amazonian slopes certainly offers suitable habitat, and *Centrolenella* are known from southern Perú (Duellman, 1976). In fact, the absence of Bolivian *Centrolenella* is an artifact of collections; two recently discovered glass-frogs are described in this paper.

In January 1979, Thomas J. Berger and I collected in the *yungas* of the Chapare region, northeast of Cochabamba, Bolivia (Fig. 1). From the city of Cochabamba (2,600 m) the road winds northeasterly to a pass (3,370 m, km 40.5) and descends through the town of Colomi (3,240 m, km 47.7) in the drainage of the Río Corani. At about 3,000 m the upper edge of the pristine forest is reached; tree ferns and viney bamboo are present. The road heads east and enters the drainage of the Río Santa Isabel. The cloud forest on the upper slopes of the valley is virtually uncut (Fig. 2); numerous streams drain the slopes.

There is a short tunnel through the mountainside at km 86.8, 1,950 m. From km 101 to km 122 the road descends rapidly from 1,950 m to 860 m. The small village of Villa Tunari is at km 160 (300 m). One of our collection sites was a tiny rivulet at km 102, 1,980 m, 15.2 km NE (downhill) of the tunnel. Alternatively, the locality can be described as 58.1 km SW Villa Tunari. Our efforts yielded a small collection of frogs, including two new species of *Centrolenella*. This is the first record of the family Centrolenidae from Bolivia.

*Methods.*—In the following descriptions, the diagnoses follow the format of Lynch and Duellman (1973). The webbing formulae are described as in Savage and Heyer (1967); snout-vent length is abbreviated SVL. For specimen comparisons I have examined the material in The University of Kansas

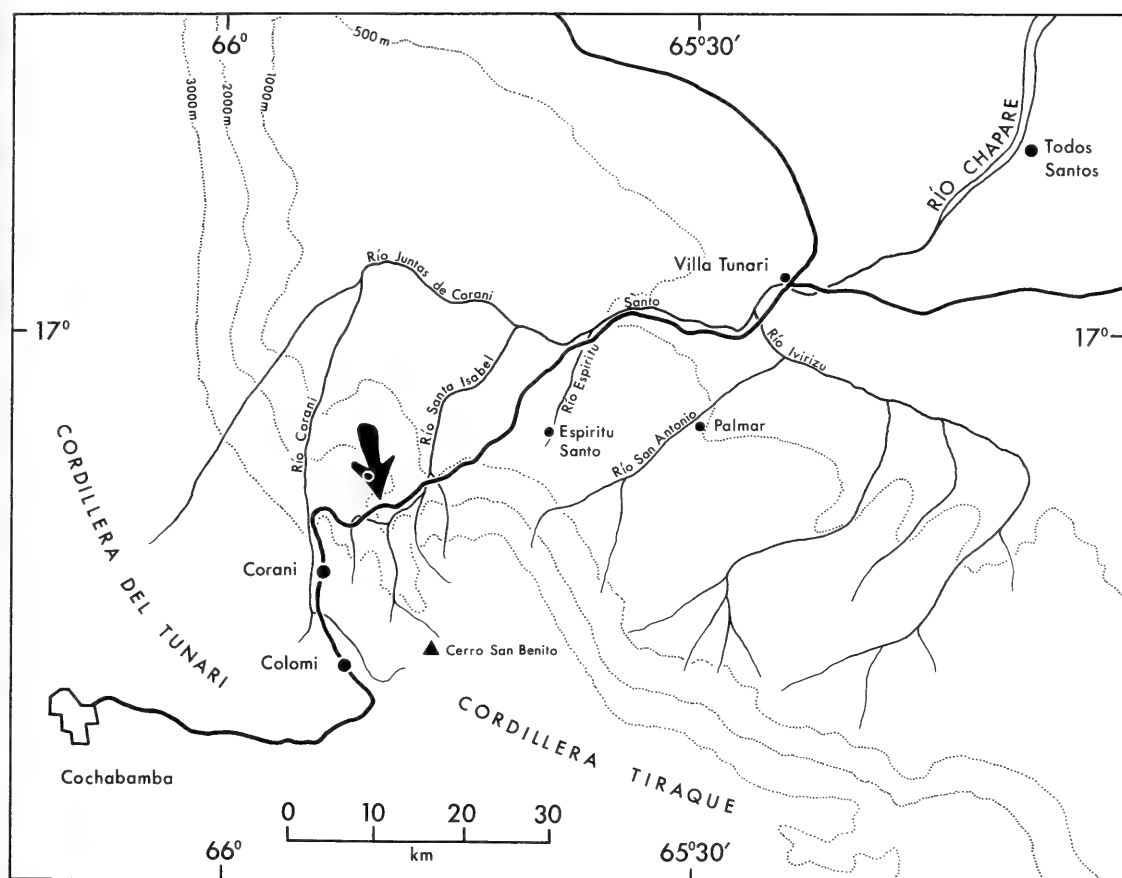


Fig. 1. Map indicating type locality (arrow) of *Centrolenella bergeri* and *Centrolenella bejaranoi*, 58.1 km SW Villa Tunari (by road), 1,980 m, Departamento Cochabamba, Bolivia.

Museum of Natural History (KU) listed by Lynch and Duellman (1973) and Duellman (1976). Color notes from life are taken from the field notes of William E. Duellman and the author. The color of the peritoneum in preserved specimens was determined by cutting into the abdomen and recording from direct observation. Fig. 1 was redrawn from Mapa de Bolivia, 1:1,000,000, 1973, Instituto Geográfico Militar, Bolivia.

*Centrolenella bejaranoi*, new species

Fig. 3

**Holotype.**—KU 182369, adult male, 23.8 mm SVL, from 58.1 km SW Villa Tunari (by road), 1,980 m, Departamento Cochabamba, Bolivia (65°50'W, 17°11'S), obtained 21 January 1979, by Thomas J. Berger and David C. Cannatella.

**Paratypes.**—KU 182370-1, same data as the holotype.

**Diagnosis.**—1) Prevomerine teeth absent; 2) bones pale green in life; 3) parietal peritoneum mostly clear, the portion immediately ventral to the

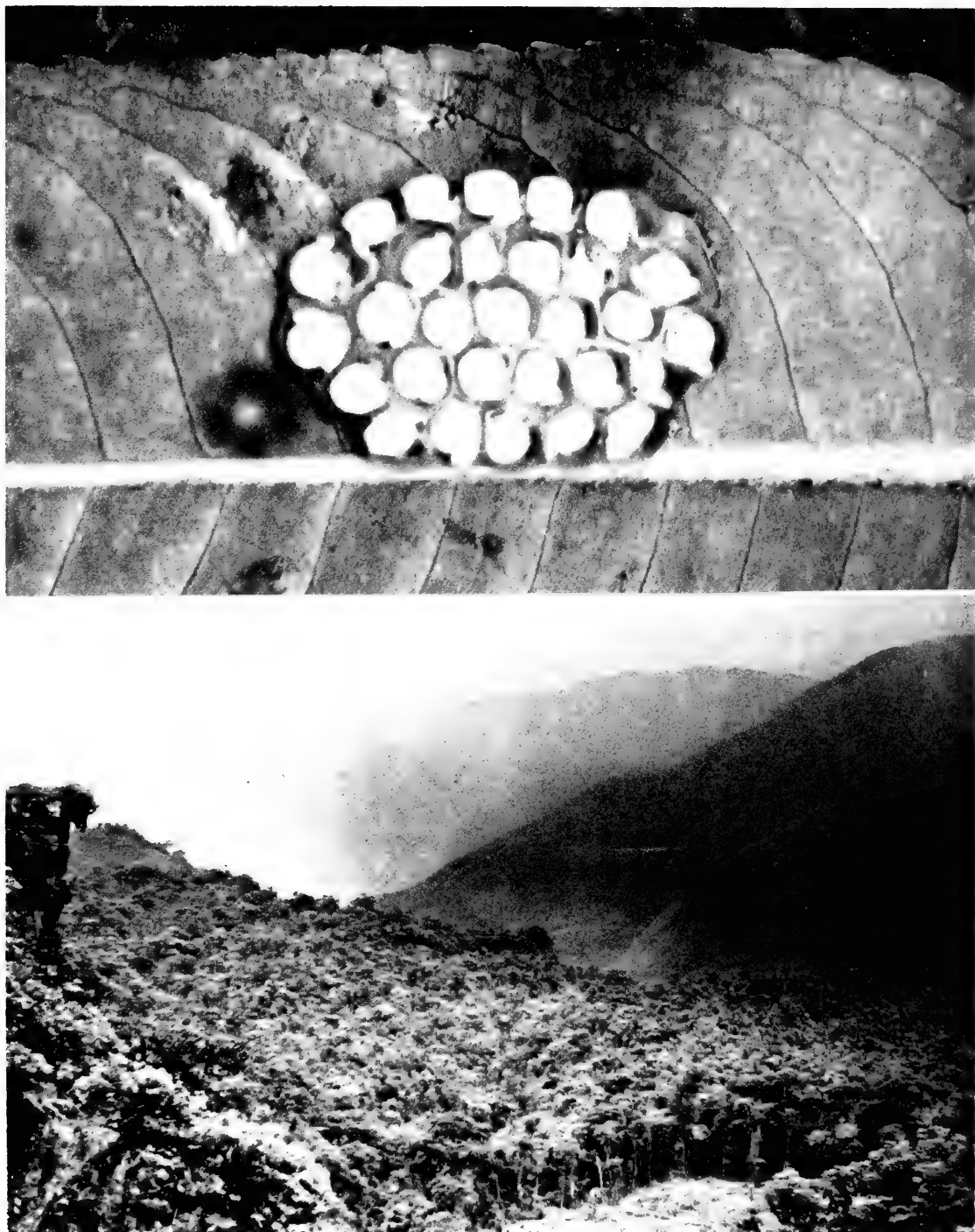


Fig. 2. **Top:** Egg clutch of *C. bergeri*, KU 182372; horizontal diameter approximately 25 mm. **Bottom:** View of cloud forest at type locality.

heart white; pericardial peritoneum ventral to the heart white; visceral peritoneum clear; 4) color in life dark green with minute off-white spots on dorsal surfaces; in preservative, lavender with minute white spots; 5) webbing formula of fingers III(3—3<sup>-</sup>)IV; 6) webbing formula of toes I(2—



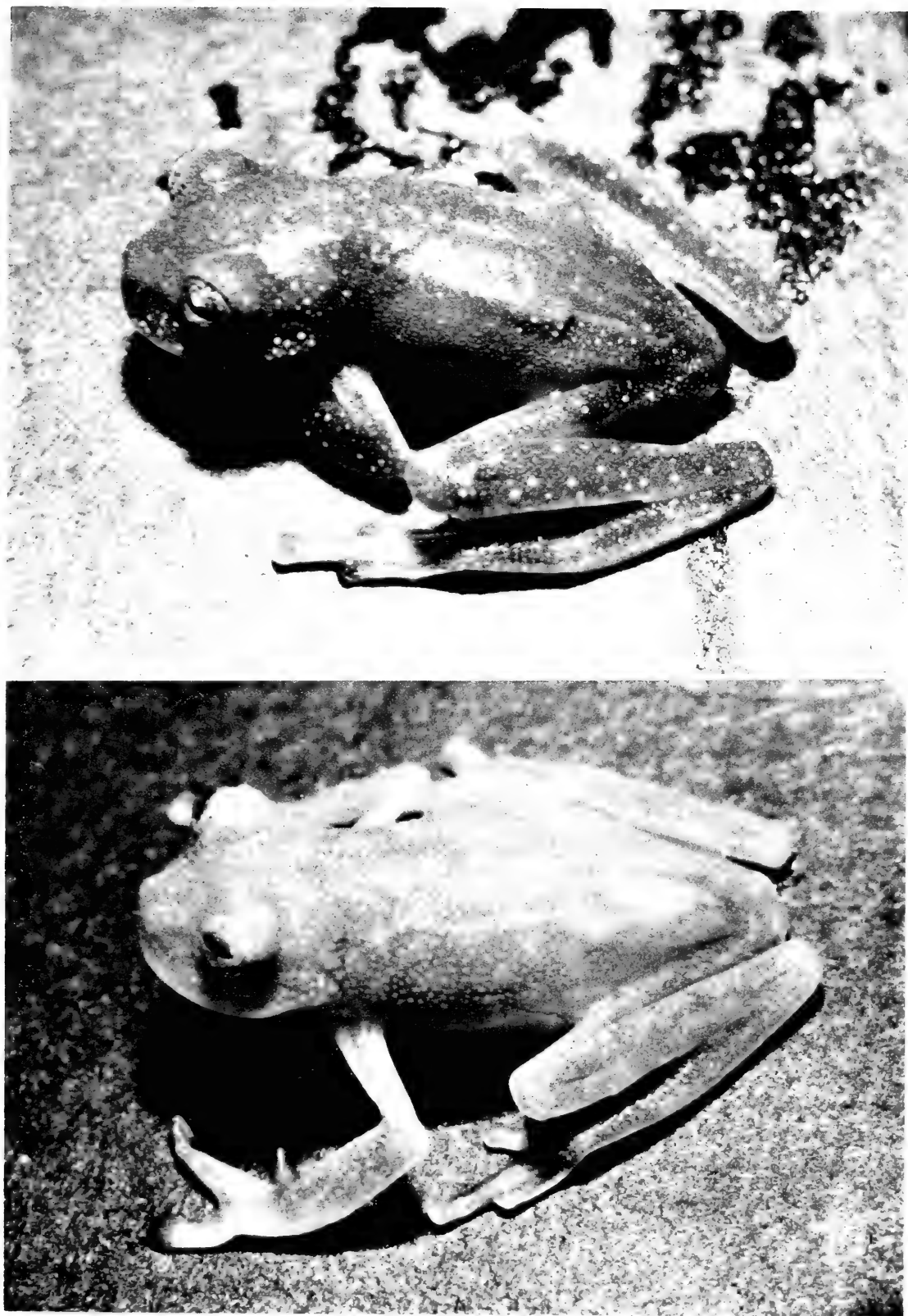


Fig. 3. **Top:** *Centrolenella bejaranoi*, male, paratype, KU 182370, SVL 24.4 mm. **Bottom:** *Centrolenella bergeri*, male, paratype, KU 182364, SVL 23.8 mm.



2.5)II(1.25—2.5)III(1.25—2.5)IV(2.5—1.5)V; 7) snout round in dorsal view; subtruncate in lateral profile; 8) dorsal skin spiculate; 9) forearm and tarsus lacking conspicuous dermal folds; 10) humeral spine absent in males; 11) lower three-fourths of tympanum visible, oriented dorsolaterally, with slight posterior inclination.

The presence of a spiculate dorsum which is lavender in preservative distinguishes this species from most other Andean species of *Centrolenella*. *Centrolenella buckleyi*, *C. spiculata*, *C. truebae*, and *C. johnelsi* have spicules on the dorsal surfaces. The much larger *C. buckleyi* differs by having humeral spines in the males and lacking white spots; *C. truebae* differs by having dark flecks on the dorsum and a denser arrangement of spicules than *C. bejaranoi*. *Centrolenella spiculata* is similar to *C. bejaranoi* in the general appearance and density of spicules, but has prevomerine teeth and much more extensive webbing. The spicules of *Centrolenella bejaranoi* are heterogenous in size; those of *C. buckleyi*, *C. truebae*, and *C. spiculata* are rather homogenous in size.

Cochran and Goin (1970) described *Centrolenella johnelsi* from a single male specimen from Medellin, Colombia. I have not examined specimens of *C. johnelsi*, but have relied on the description and also notes on the holotype provided by William E. Duellman for the following comparisons: *Centrolenella bejaranoi* and *C. johnelsi* have spiculate dorsa and lack prevomerine teeth. However, *C. johnelsi* is a much larger frog (29.3 mm vs. 23.8–24.4 mm in males) than *C. bejaranoi*. Also, *C. johnelsi* possesses humeral spines; these are absent in *C. bejaranoi*.

*Description*.—Adult males of moderate size for centrolenid frogs; SVL 23.8–24.4 mm ( $\bar{x}$  = 24.1,  $n$  = 3); females unknown. Head slightly wider than body; snout short, round in dorsal view, subtruncate in lateral view; canthus round and indistinct, loreal region slightly concave; lips not flared; nostrils nearly terminal on snout, not flared, directed laterally, internarial region concave. Eye moderately large, directed anterolaterally. Supratympanic fold obvious; lower three-fourths of tympanum visible, directed anterolaterally with slight posterior inclination. Prevomerine dentigerous processes and teeth absent; choanae oval; tongue broadly cordiform, slightly free posteriorly; short vocal slits present in males, extending from angle of jaw almost to midlateral edge of tongue.

Humeral spine absent; conspicuous dermal folds lacking; order of fingers from shortest to longest 1-2-4-3; webbing absent between first three fingers (Fig. 4); fingers lacking lateral fringes; finger discs broad, subtruncate; subarticular tubercles small, round, single; supernumerary tubercles absent; palmar tubercle moderately large, round, single; thenar tubercle elliptical.

Hind limbs slender; tibia length 53.3–56.6% of SVL; conspicuous tarsal fold absent; inner metatarsal tubercle small, flattened, elliptical; outer metatarsal tubercle absent; subarticular tubercles small, round; supernumerary

tubercles absent; toes about one-half webbed (Fig. 5); discs rounded to slightly truncate, smaller than those on fingers.

Skin on dorsal surfaces bearing spicules of heterogenous sizes; spicules present on upper eyelids and upper lip. Skin of belly and ventral thighs granular; chin, forelimbs, flanks, and shanks smooth. Anal opening directed posteriorly at upper level of thighs; anal tubercles and ornamentation absent.

*Color in preservative.*—Dorsal surfaces lavender with minute white spots, each white spot enclosing a large spicule. Ventral surfaces white or transparent.

*Color in life.*—Dorsal surfaces dark green with minute off-white spots. Digits orange-green; chest white; parietal peritoneum generally clear, that portion ventral to the heart is white; pericardial peritoneum covering ventral surface of the heart white; visceral peritoneum clear; bones and vocal sac pale green. Iris metallic yellow with black flecks.

*Distribution.*—This species is known only from the type locality in cloud forest of the Chapare region of the *yungas* of Bolivia (Fig. 1).

*Etymology.*—This species is named in honor of Professor Gastón Bejarano B., government official and naturalist, who encouraged and supported our work in Bolivia.

*Remarks.*—The stream where *C. bejaranoi* was collected is about 0.5 m wide; the stream bed consists of small rocks and gravel. The frogs were collected from heights of 1–2 m above the stream by night within 25 m of the road. This species was not observed to be calling.

Lynch and Duellman (1973) distinguished three patterns of peritoneal pigmentation among *Centrolenella*: 1) clear parietal, white visceral (*C. fleischmanni* and *pulverata* groups, and *C. albotunica*, *C. eurygnatha*, and *C. vanzolinii* of southeastern Brasil); 2) white parietal, clear visceral (*C. prosoblepon* group); and 3) white parietal, white visceral (*C. antioquiensis* and *C. resplendens*).

In the pattern of peritoneal pigmentation, as well as in other characters, *C. bejaranoi* fits most readily, though not clearly, in the *C. prosoblepon* group. The visceral peritoneum is without pigment; only a small portion of the parietal peritoneum, immediately ventral to the heart, is white. There may be intraspecific variation in the extent of the white pigment in centrolenid frogs, but such variation is not exhibited in the type series of *C. bejaranoi*.

*Centrolenella bergeri*, new species

Fig. 3

*Centrolenella munozorum* (partim)—Duellman, 1976, p. 2.

*Holotype.*—KU 182363, adult male, 24.8 mm SVL, from 58.1 km SW

Villa Tunari (by road), 1,980 m, Departamento Cochabamba, Bolivia (65°50'W, 17°11'S), obtained 21 January 1979, by Thomas J. Berger and David C. Cannatella.

*Paratypes*.—KU 182364–8, collected 21–22 January 1979, same locality and collectors as the holotype.

*Referred specimens*.—KU 162248–50, Perú:Cuzco:Río Cosñipata, 4 km SW Santa Isabel, 1,700 m. KU 162251–8, 162259–60 (eggs), Perú:Ayacucho: Tutumbaro, Río Piene, 1,840 m.

*Diagnosis*.—1) Prevomerine teeth absent; 2) bones white in life; 3) parietal peritoneum clear; visceral peritoneum white; 4) color in life pale yellow-green with diffuse yellow spots; color in preservative creamy white; 5) webbing formula of fingers III(2.25–2<sup>+</sup>)IV; 6) webbing formula of toes I(1.5–2<sup>-</sup>)II(1.5–2)III(1.25–2.5)IV(2.75–1.5)V; 7) snout round in dorsal view, subtruncate in lateral view; 8) dorsal skin shagreened; 9) forearm and tarsus lacking conspicuous dermal folds; 10) humeral spine absent in males; 11) tympanum concealed beneath skin, strongly oriented dorsolaterally.

Few Andean *Centrolenella* (*Centrolenella munozorum*, *C. pellucida*, and *C. fleischmanni*) are creamy white in preservative. *Centrolenella bergeri* differs from *munozorum* in the extent of webbing and relative size of the fingers (Fig. 4). *Centrolenella fleischmanni* has a visible tympanum; it is concealed in *C. bergeri*. *Centrolenella pellucida* has more extensive webbing on the hands and bears well-developed dermal folds on the limbs and below the anus (see remarks); *C. bergeri* lacks such dermal folds.

*Description*.—Adult males of moderate size for centrolenid frogs; SVL 22.7–26.5 mm ( $\bar{x}$  = 24.0,  $n$  = 13); females 23.2–26.3 mm ( $\bar{x}$  = 24.8,  $n$  = 2); A Mann-Whitney test between SVL's of males ( $n$  = 5) from Río Santa Isabel, Bolivia, and males ( $n$  = 7) from Río Piene, Perú, demonstrates that the samples are not different in SVL ( $0.3 > P > 0.2$ ). SVL is correlated with tibia length (Spearman rank correlation coefficient,  $r$  = 0.80;  $P < 0.001$ ); the mean ratio of tibia length/SVL equals 0.524,  $n$  = 12.

Head wider than body; snout short, round in dorsal view, subtruncate in lateral view; canthus round, indistinct, loreal region barely concave; lips not flared; nostrils nearly terminal, directed laterally; internarial region flat. Eyes large, protuberant, directed anterolaterally. Supratympanic fold absent; tympanum concealed beneath skin. Prevomerine dentigerous processes and teeth absent; choanae large, oval; tongue round, barely free posteriorly; short vocal slits present in males, extending from angle of jaw almost to midlateral border of tongue.

Humeral spine absent; conspicuous dermal folds lacking; order of fingers from shortest to longest 2-1-4-3; fingers slightly webbed (Fig. 4); finger discs moderately large, rounded; fingers with narrow lateral fringes; subarticular tubercles small, low; supernumerary tubercles absent; palmar tubercle indistinct.

Hind limbs slender; tibia length 52.4% (mean) of SVL; conspicuous dermal folds lacking; inner metatarsal tubercle small, ovoid; outer metatarsal tubercle absent; subarticular tubercles small, low; supernumerary tubercles absent; toes about three-fourths webbed (Fig. 5); discs on toes round, smaller than those on fingers.

Skin on dorsal surfaces of head and body shagreened; skin on venter granular; skin on other surfaces smooth; anal opening directed posteriorly at upper level of thighs; anal ornamentation and tubercles absent.

*Color in preservative.*—Dorsal surfaces creamy white with minute purple flecks (chromatophores); ventral skin transparent.

*Color in life.*—Dorsum pale green with diffuse yellow spots; venter and concealed surfaces without pigment; digits orange-yellow; parietal peritoneum clear, pericardial peritoneum clear; visceral peritoneum white, bones white. Iris metallic yellow-white with a few black flecks.

*Distribution.*—The species is known in Bolivia only from the type locality on the Amazonian slopes of Departamento Cochabamba (Fig. 1) and from two localities in cloud forest of the Cordillera Oriental in southern Perú (see maps in Duellman, 1976, 1978). The known elevational range of the species is 1,700–1,980 m. There is a gap of about 700 km between the Bolivian and Río Cosñipata (Perú) populations.

*Etymology.*—This species is named for Thomas J. Berger, who provided comic relief while securing part of the type series.

*Remarks.*—Duellman (1976) tentatively referred specimens from southern Perú to *Centrolenella munozorum*. He remarked that specimens from the Río Cosñipata and Río Piene have less webbing on the hands and feet and are larger than *C. munozorum* from Ecuador, differences of a magnitude usually seen between species of *Centrolenella* but perhaps representing clinal variation. Duellman also noted that the Ecuadorian and Peruvian populations were identical in coloration and lacked structural differences.

I have compared directly the holotype and most of the paratypes of *C. munozorum* with *C. bergeri* from Perú and Bolivia. In the former species the fingers are relatively much shorter and more fully webbed than those of the latter (compare Fig. 4A, this paper, with Fig. 3D, Lynch and Duellman, 1973). The samples from southern Perú and Bolivia exhibit no differences among themselves, but are substantially different from *C. munozorum*. Specimens of *C. munozorum* reported by Duellman (1976) and Tøft and Duellman (1979) from 200 m in Departamento Huánuco, Perú, are identical with the Ecuadorian *C. munozorum*.

*Centrolenella bergeri* is most similar to *C. pellucida*, from the Amazonian versant of Ecuador. The two species agree closely in many characters; *C. pellucida* has more webbing on the hands and feet than does *C. bergeri*, but the proportions of the hands and feet are quite similar. The species are identical in coloration. One of the diagnostic features of *C. pellucida*—

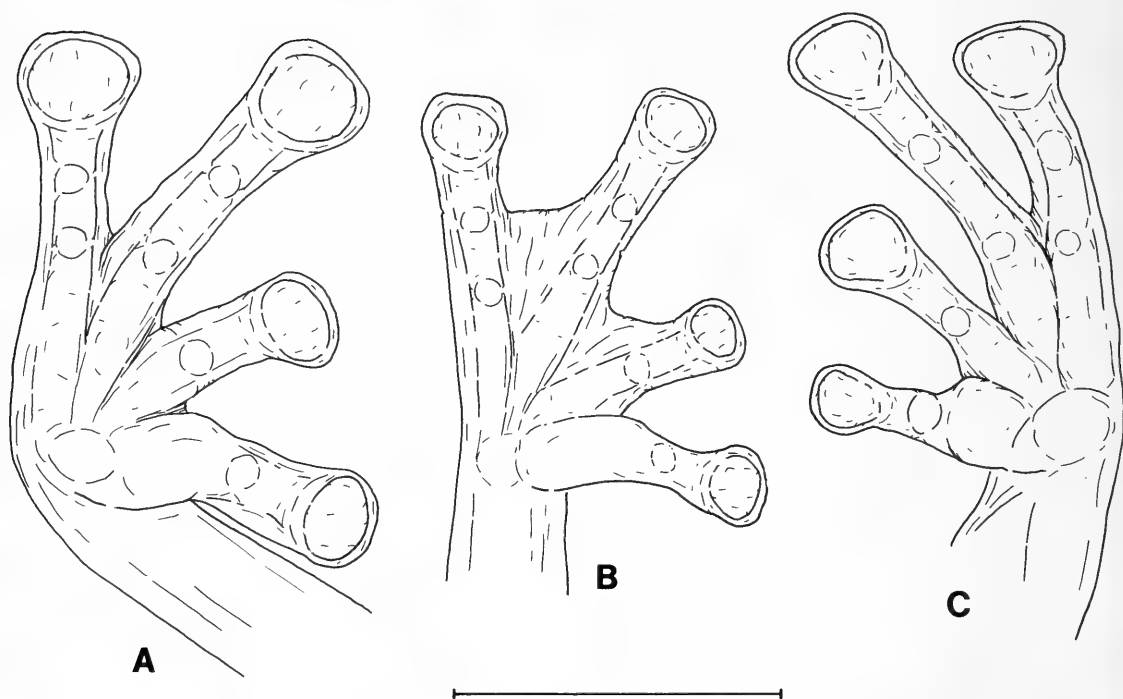


Fig. 4. Palmar view of hands: **A**, *Centrolenella bergeri*, paratype, KU 182366; **B**, *Centrolenella pellucida*, holotype, KU 143298; **C**, *Centrolenella bejaranoi*, paratype, KU 182371. Line equals 5 mm.

known only from the holotype—is an unscalloped dermal fold on the outer edge of the hand and forearm, and on the foot and tarsus; a second character is a transverse dermal fold below the anus (Lynch and Duellman, 1973). Having examined the holotype of *C. pellucida* (KU 143298), I believe that the subanal dermal fold represents a preservation artifact. The dermal folds along the limbs also may be due partly to preservation.

The holotype of *C. pellucida* is a gravid female, SVL 22.0 mm. This is smaller than the smallest male (22.7 mm) and female, also gravid, (23.2 mm) of *C. bergeri*.

*Centrolenella bergeri* obviously belongs to the group of species—*C. fleischmanni*, *C. munozeum*, and *C. pellucida*—that has white bones in life, white visceral peritoneum, clear parietal peritoneum, white ground color in preservative, and lacks prevomerine teeth and dentigerous processes, humeral spines, subanal tubercles, and distinct canthi (Lynch and Duellman, 1973). The southernmost reported locality of *C. fleischmanni* is Quevedo, Pacific lowlands of Ecuador (Noble, 1924). The lowland species *C. munozeum* ranges south to the Río Lullapichis in central Perú (Toft and Duellman, 1979). *Centrolenella pellucida* is known only from the cloud forest of the Río Coca drainage of the Amazonian slopes of Ecuador. No members of the group are known from the cloud forests of southern Ecuador and

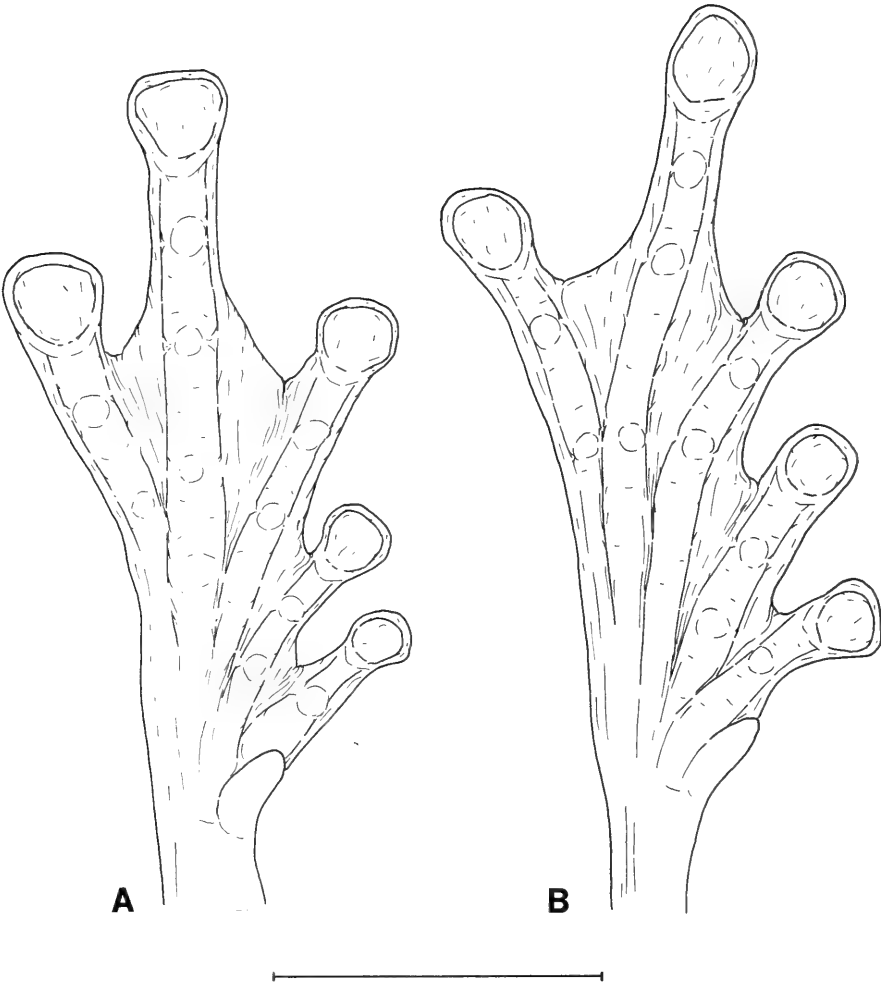


Fig. 5. Plantar view of feet: **A**, *Centrolenella bejaranoi*, holotype, KU 182369; **B**, *Centrolenella bergeri*, paratype, KU 182366. Line equals 5 mm.

northern Peru; a gap of about 1,500 km airline separates the closest records of *C. pellucida* and *C. bergeri*.

*Life history notes.*— Several of the males of the type series were observed calling from the undersides of leaves 1–3 m above the stream at night. KU 182364 called from the underside of a leaf while sitting about 4 cm from an egg clutch (KU 182372). The egg clutch consists of 29 embryos at Stage 18 (Gosner, 1960), arranged in a monolayer on the underside of the leaf, not hanging from the leaf tip. In life, the jelly is clear and the embryos are pale green (Fig. 2). Duellman (1976) commented on a male calling adjacent to a clutch of 25 eggs at the Río Piene in Perú. *Centrolenella bergeri* and *C. bejaranoi* were taken at the same stream in Bolivia. At the Río Cosñipata in Peru, *C. bergeri* was found with *C. spiculata*, *C. truebae*, and a specimen referred to *C. ocellata*. At the Río Piene *C. bergeri* occurred with specimens referred to *C. siren* (Duellman, 1976).

### Acknowledgments

Thomas J. Berger accompanied me in the field in Bolivia; I am grateful for his companionship. Professor Gastón Bejarano B. of the Departamento Nacional de Vida Silvestre, Parques Nacionales, Caza y Pesca, of Bolivia issued collecting and export permits and made our work in Bolivia enjoyable. William E. Duellman and John D. Lynch offered support and encouragement. Field work was supported by a grant (DEB 76-09986, William E. Duellman, principal investigator) from the National Science Foundation, and by a National Science Foundation Graduate Fellowship to the author.

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# RECORDS OF ANTHURIDS FROM FLORIDA, CENTRAL AMERICA, AND SOUTH AMERICA (CRUSTACEA: ISOPODA: ANTHURIDAE)

Brian Kensley

*Abstract.*—Notes on morphology and new distributional records for *Apanthura magnifica* Menzies and Frankenberg, *Haliophasma curri* Paul and Menzies, *Malacanthura caribbica* Paul and Menzies, *Skuphonura laticeps* Barnard, and *Xenanthura brevitelson* Barnard are presented. *Skuphonura itapuca* new species, and *S. ecuadorensis* new species, are described.

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As part of a series of short contributions on anthurid isopod taxonomy, several scattered records in the Smithsonian collections from Florida, the Caribbean, Central and South America are combined prior to a generic revision of the group.

## Family Anthuridae

### *Apanthura magnifica* Menzies and Frankenberg

Figs. 1, 2

*Apanthura magnifica* Menzies and Frankenberg, 1966:40, fig. 17.—Schultz, 1969:99, fig. 134.—Kruczynski and Myers, 1976:353, figs. 1, 2.—Camp, Whiting, and Martin, 1977:15.

*Previous records.*—Off Georgia, 17–137 m; Off Florida, 7–11 m.

*Material examined.*—Gandy Shell Bar, Florida: 10 July 1966, 2 ♀; 1 Oct. 1966, 90 ♀, 43 juv.; 9 Nov. 1966, 27 ♀, 10 juv.; 14 Dec. 1966, 32 ♀, 10 juv.; 18 Jan. 1967, 36 ♀, 11 juv.; 12 Apr. 1967, 18 Apr. 1967 6 ♂ (7.5%) 80 ♀, +100 juv.; 17 May 1967, 8 ♂ (12.9%) 62 ♀, +100 juv.; 14 June 1967, 8 ♂ (6.4%) 47 ♀; 17 Aug. 1967, 66 ♀, 50 juv.; 20 Sept. 1967, 2 ♂; St Joseph Bay Florida, 22 ♀.

*Remarks.*—Kruczynski and Myers (1976) noted an immature (submale) stage in *A. magnifica*, characterized by the possession of a multiarticulate antennular flagellum, but lacking whorls of aesthetascs, and suggested that the species is protogynous as is *Cyathura*. The large sample from Gandy Shell Bar, Florida, illustrates the low percentage of males in this anthurid population. This sample also provides evidence of possibly two stages of immature male. The first is in all respects similar to the mature female, except for pereopod 1 which is identical with that of a mature male, with



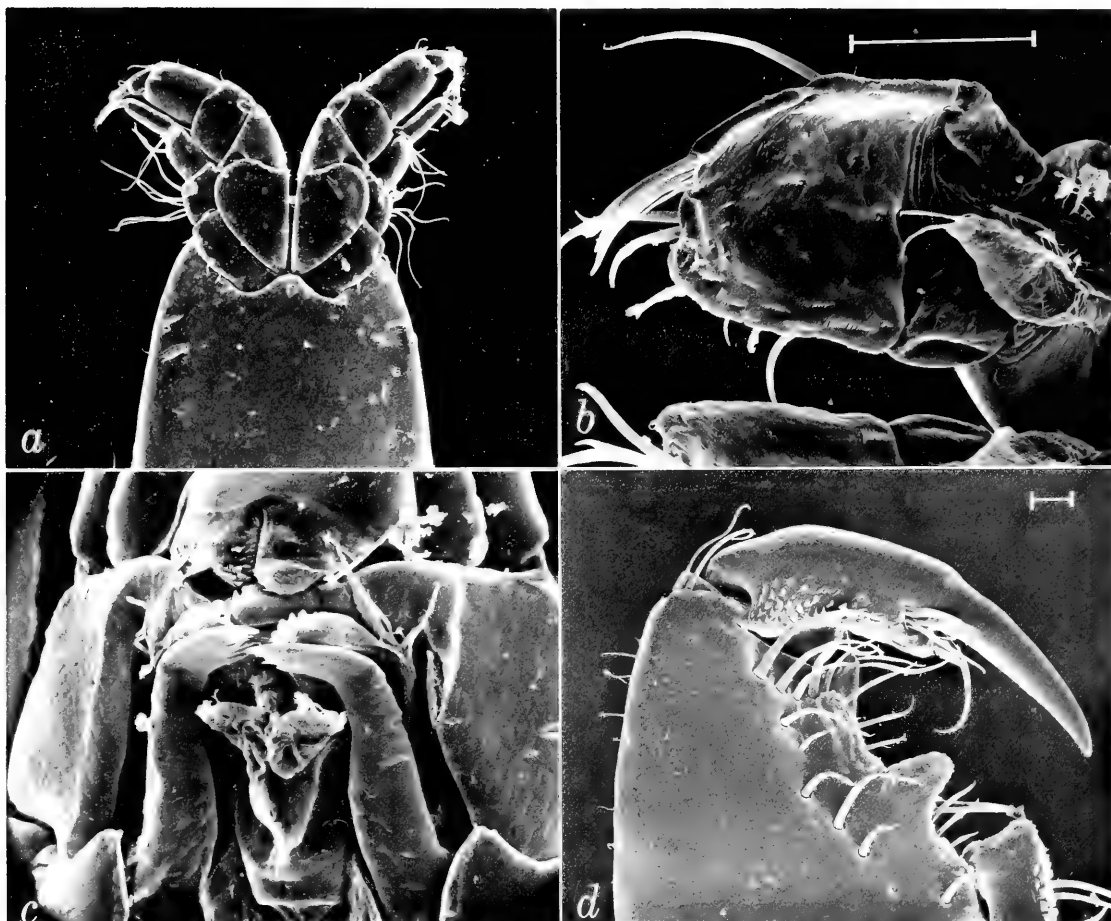


Fig. 1. *Apanthura magnifica*: a, Anterior cephalon in dorsal view; b, Inner view of maxilliped showing endite; c, Mouthparts in situ, maxillipeds removed; d, Pereopod 1, propodus and dactylus.

its more strongly developed palmar tooth and distal carpal process. The second submale stage shows both the typical male pereopod 1 as well as the multiarticulate flagellum of the antennule lacking aesthetascs. The endopod of pleopod 2 does not carry an appendix masculina. The mature male possesses both aesthetascs on the antennule as well as an appendix masculina on the second pleopod.

Kruczynski and Myers (1976) state that the basal antennal peduncular segment is grooved to accommodate the antennule. In fact, it is the second segment which is grooved.

Both Menzies and Frankenberg (1966), and Kruczynski and Myers (1976) figure the pleon of *A. magnifica* as having pleonites 1–3 free, and pleonites 4 and 5 partially fused. Clearing a specimen in lactic acid and chlorazol black, as well as scanning electron micrographs clearly show pleonites 1–5 to be fused, with sutures indicated laterally by slits, and with slight dorsal folds linking the lateral slits (Fig. 2a, b).

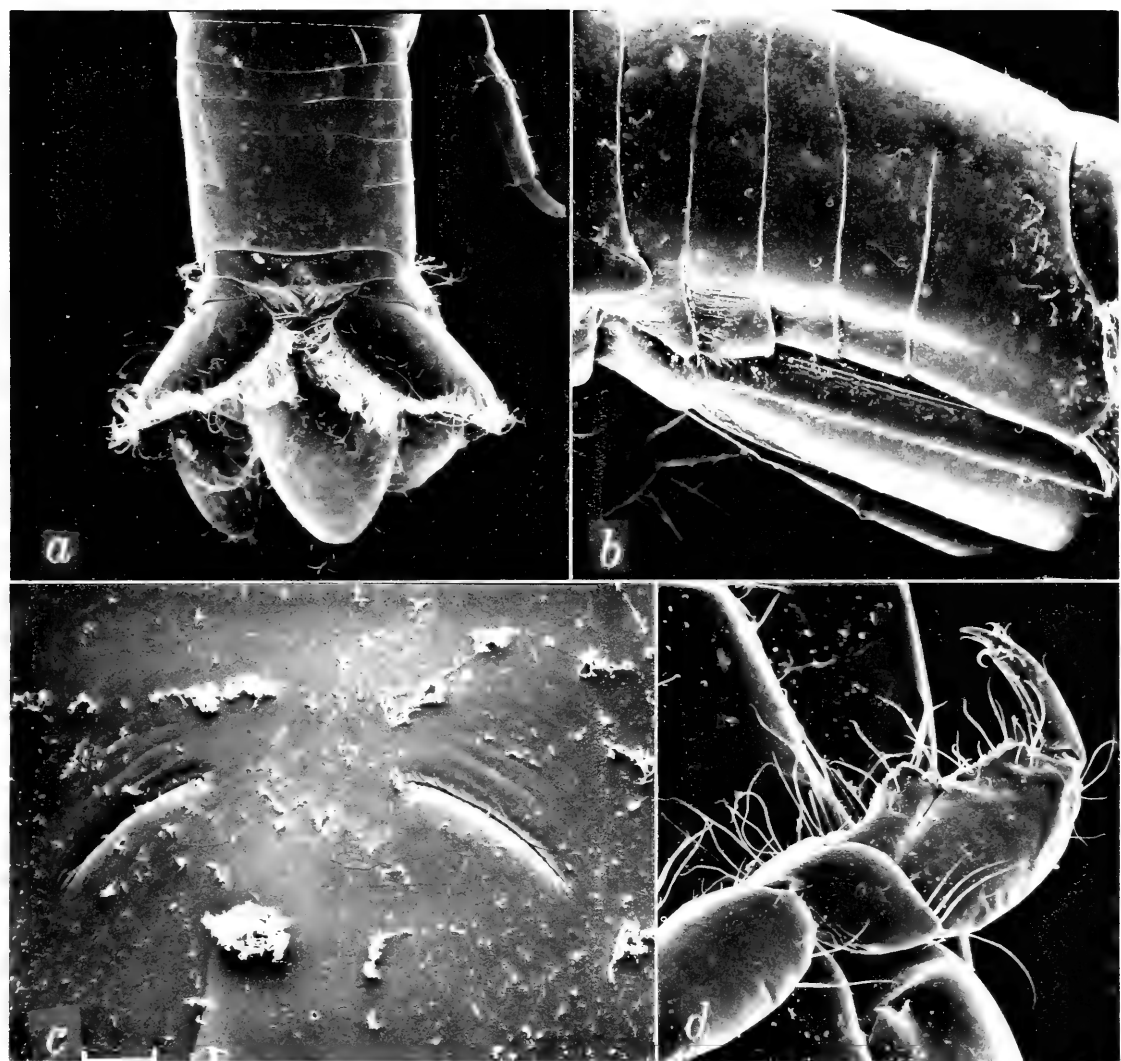


Fig. 2. *Apanthura magnifica*: a, Pleon and telson in dorsal view; b, Pleon in lateral view; c, Dorsal openings of statocysts at base of telson; d, Pereopod 7.

*Haliophasma curri* Paul and Menzies  
Fig. 3i

*Haliophasma curri* Paul and Menzies, 1971:39, figs. 16, 17.—Poore, 1975:532.

*Previous records*.—Off Venezuela, Cariaco Basin, 11°03'N, 64°37'W, 95 m.

*Material examined*.—USNM 136418 Holotype ♀ TL 7.0 mm. USNM 136419 Paratype ♀ TL 7.0 mm. USNM 173520, ♀ TL 7.7 mm, Culebra Island, Bay of Panama, intertidal.

*Remarks*.—Poore (1975) mentions that the lack of dorsal pereonal grooves and pits, and the presence of a 5-segmented maxilliped (as given in the

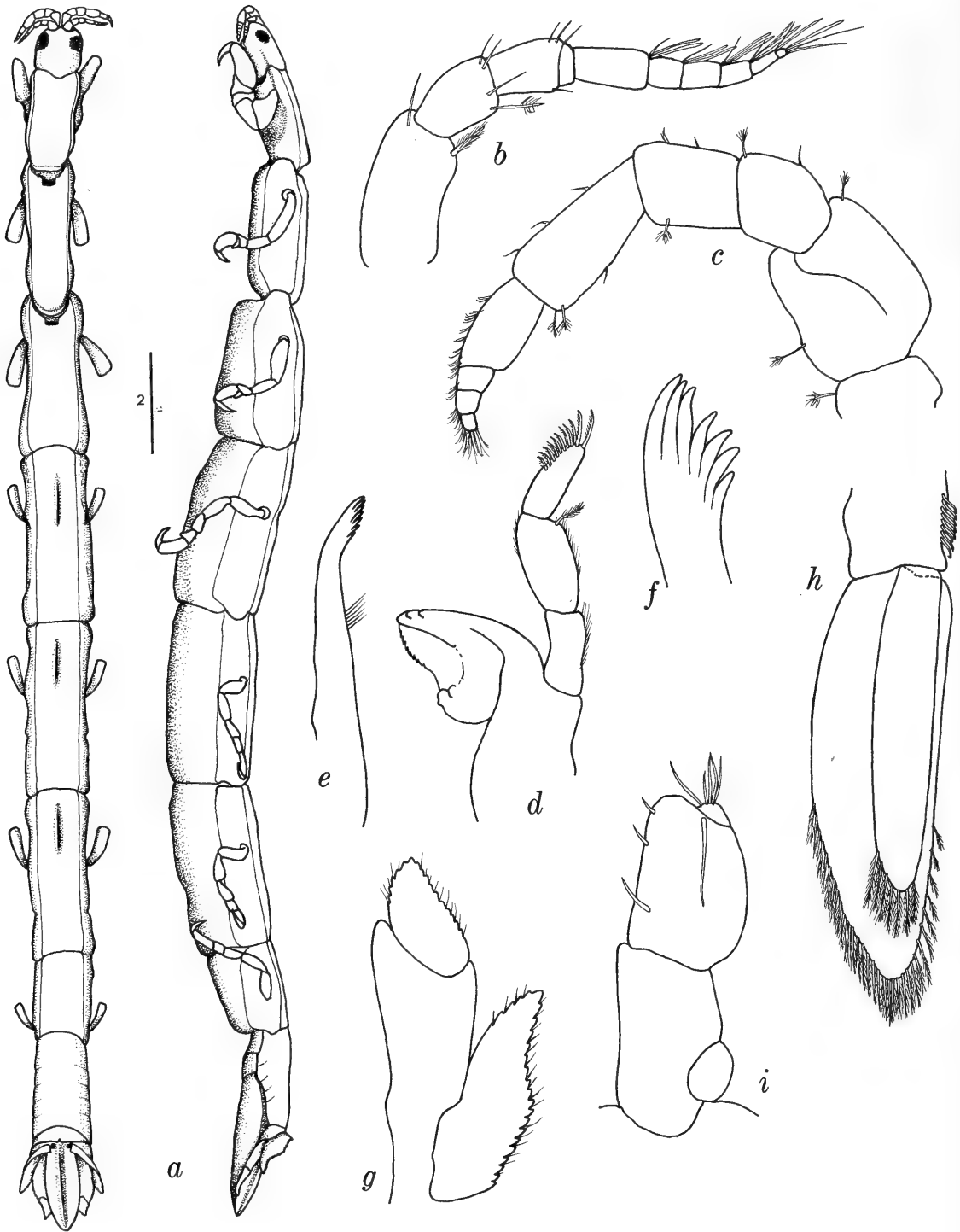


Fig. 3. *Malacanthura caribbica*: a, Adult ♀ in dorsal and lateral view; b, Antennule; c, Antenna; d, Mandible; e, Maxilla; f, Apex of maxilla; g, Uropod; h, Pleopod 1; i, *Haliophasma curri*: maxilliped.

original description) would exclude *H. curri* from *Haliophasma* s.s. as re-defined by him. Examination of the type-material and the Panamanian specimen shows that dorsolateral grooves are present (as they are in all anthurids), and that Paul and Menzies probably mistook a fold in the second maxillipedal segment for a suture. The maxilliped is 4-segmented and except for the presence or absence of dorsal pits on pereonites 4–6 (a difficult feature to see in such small and transparent specimens) *H. curri* fits Poore's definition of *Haliophasma*.

This second record of the species, from the Pacific side of the Panama Canal, raises the questions of earlier distributional patterns, and the movement of species through the canal, but gives little basis for fruitful speculation.

*Malacanthura caribbica* Paul and Menzies

Figs. 3, 4

*Malacanthura caribbica* Paul and Menzies, 1971:34, figs. 8, 9.

*Malacanthura cumanaensis* Paul and Menzies, 1971:35, figs. 10, 11.

*Description*.—♀. Body 17 times longer than wide; integument moderately indurate. Cephalon half length of pereonite 1, with large eyes. Proportions:  $C < 1 < 2 = 3 < 4 = 5 = 6 > 7$ . Pereonites 2 and 3 with middorsal rectangular pit-like depression on anterior margin; pereonites 4–6 with longitudinal middorsal slit-like depressions. Pleonites 1–5 fused, segments faintly indicated ventrolaterally; pleonite 6 free, with middorsal notch in posterior margin. Telson strongly indurate, narrowly oval, with 2 basal statocysts and strong middorsal carina.

Antennular peduncle 4-segmented, 4th segment short; flagellum of 6 articles each bearing 2 aesthetascs. Antennal peduncle 5-segmented, 2nd segment longest and broadest, grooved to accommodate antennule; flagellum of 4 articles. Mandibular palp 3-segmented, terminal segment with 11 serrate spines; incisor with 3 cusps; molar reduced, rounded; lacinia with 8 or 9 serrations. Maxilla slender, with 7 distal spines. Maxilliped 5-segmented, 3rd segment with concave outer margin, 4th segment with row of 7 short serrate spines; scattered serrate spines on all segments as well as short fine setules. Pereopod 1 unguis one-third length of dactylus; propodus relatively narrow, palm bearing 4 or 5 slender spines and few setae, plus group of 4 spines distally near dactylar articulation. Pereopod 2 similar to pereopod 1. Pereopods 5–7 with unguis one-fifth length of dactylus; propodus with short triangular tooth at posterodistal corner; carpus half length of propodus, not overriding propodus, with posterodistal triangular spine. Pleopod 1 exopod operculiform, indurate, with dense plumose setae on distal margin; endopod half width and three-quarters length of exopod, with 7 distal plumose setae; basis with 8 retinaculae. Uropod strongly indurate, exopod with outer mar-

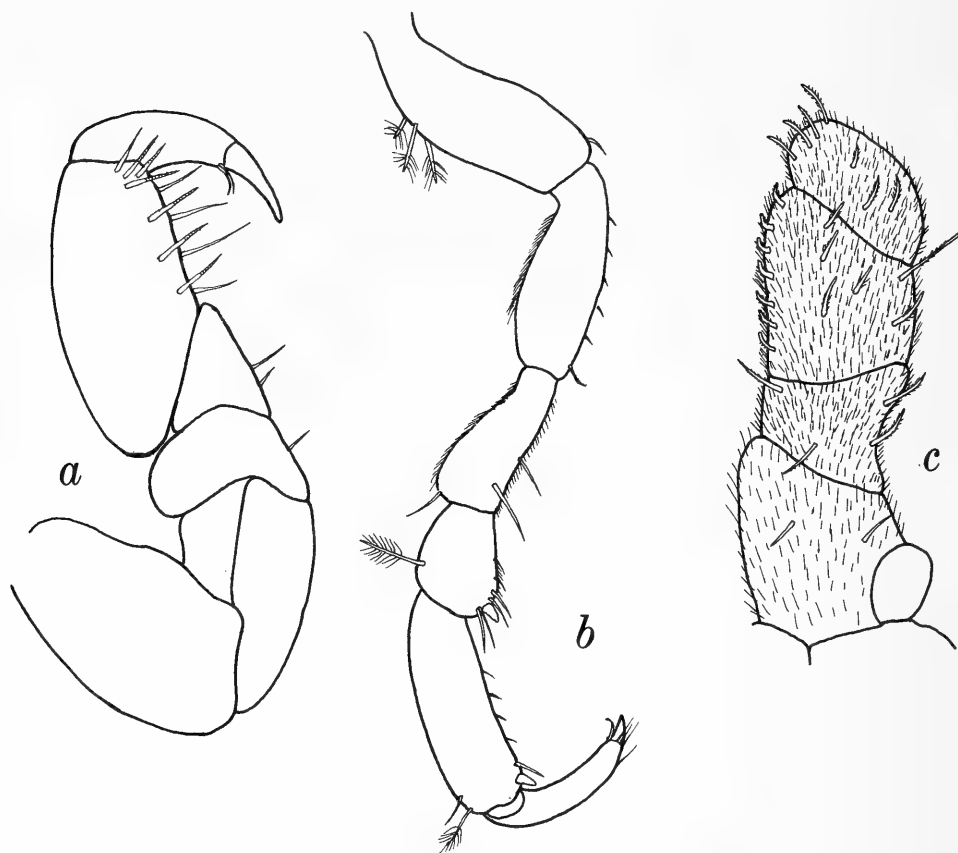


Fig. 4. *Malacanthura caribbica*: a, Pereopod 1; b, Pereopod 7; c, Maxilliped.

gin sinuate, apically subacute, margins with strong serrations, shorter than basis; latter with mediodistal corner somewhat produced, 3 times length of endopod; latter apically acute, margins strongly serrate.

*Previous records*.—Off Venezuela, 11°03'N, 64°37'W, 95 m.

*Material examined*.—USNM 136422, Holotype of *M. caribbica*, ♀ TL 17.0 mm. USNM 136423, Paratype of *M. caribbica*, ♀ TL 9.0 mm. USNM 136424, Holotype of *M. cumanensis*, ♀ TL 7.5 mm. USNM 173521, 3 ♀, TL 27.1 mm, 25.7 mm, 18.0 mm; off Cape La Vela, Colombia, 42–44 m.

*Remarks*.—The two large specimens from Colombia prompted re-examination of Paul and Menzies' two species of *Malacanthura*, both coming from the same locality off Venezuela. As all the above material shows very similar structure of the uropods and telson, mouthparts, and pereonites, it was concluded that only one species is involved here. Paul and Menzies separated *M. cumanensis* from *M. caribbica* by the former's lack of pigmentation, by maxillipedal structure, and by the lack of serrations on the uropodal exopod. With the exception of species of *Mesanthura*, pigmentation would seem to be an unreliable character for specific separation in the anthurids. Re-examination of the maxilliped and uropod showed that

what was taken for a sixth segment in the maxilliped of *M. caribbica* is an integumental fold in the fifth segment, and that transparent serrations are present on the uropodal exopod. Perhaps the most important feature common to all the specimens is the presence on pereonites 2 and 3 of a middorsal rectangular pit-like depression on the anterior margin, and middorsal slit-like depressions on pereonites 4–6. As the Colombian specimens are considerably larger than Paul and Menzies' type-material the above revised description is given.

*Skuphonura* Barnard 1925

*Diagnosis.*—Cephalon wider distally than proximally; anterolateral lobes extending beyond level of rostrum. Pleonites 1–5 fused, segments indicated ventrolaterally; pleonite 6 free, with middorsal slit in posterior margin. Some form of midventral tubercle or spine(s) at base of mouthparts. Flagella of antennae and antennules of single article in male and female; antennular flagellum in male with single tuft of aesthetascs. Pleopod 1 operculiform. Carpus of pereopods 4–7 triangular, underriding propodus. Pereopod 1 showing sexual dimorphism, carpus always distally produced into spinose process.

*Remarks.*—The genera *Mesanthura* and *Skuphonura* are very similar in the triangular underriding carpus of the posterior pereopods, in the 5-segmented maxilliped, and in the fusion of the pleonites. Two features, however, immediately separate them. The presence of a persistent pigment pattern in *Mesanthura* (absent in *Skuphonura*), and the uniarticulate flagella of both antennae and antennules in *Skuphonura* (*Mesanthura* has flagella of more than one article).

*Skuphonura laticeps* Barnard

Fig. 5

*Skuphonura laticeps* Barnard, 1925:145, fig. 10.—Schultz, 1969:91, Figs. 115q, 119.

*Description.*—♂. Integument not indurate. Cephalon with rounded anterolateral lobes extending beyond level of triangular rostrum, bearing dorsolateral eyes each of 10 ocelli. Blunt rounded lobe at base of mouthparts. Proportions:  $C = 1 > 2 > 3 < 4 = 5 > 6 > 7$ . Pereonite 1 with strong forwardly-directed ventral spinose process. Telson widest at midlength, apically rounded, with broad transparent margin and several lateral and distal setae. Antennular peduncle 4-segmented, basal segment almost as long as 3 distal segments together; 4th segment short, set obliquely into 3rd segment; flagellum of single short article bearing cluster of aesthetascs. Antennal peduncle 5-segmented, distal segment equal in length to 3rd and 4th

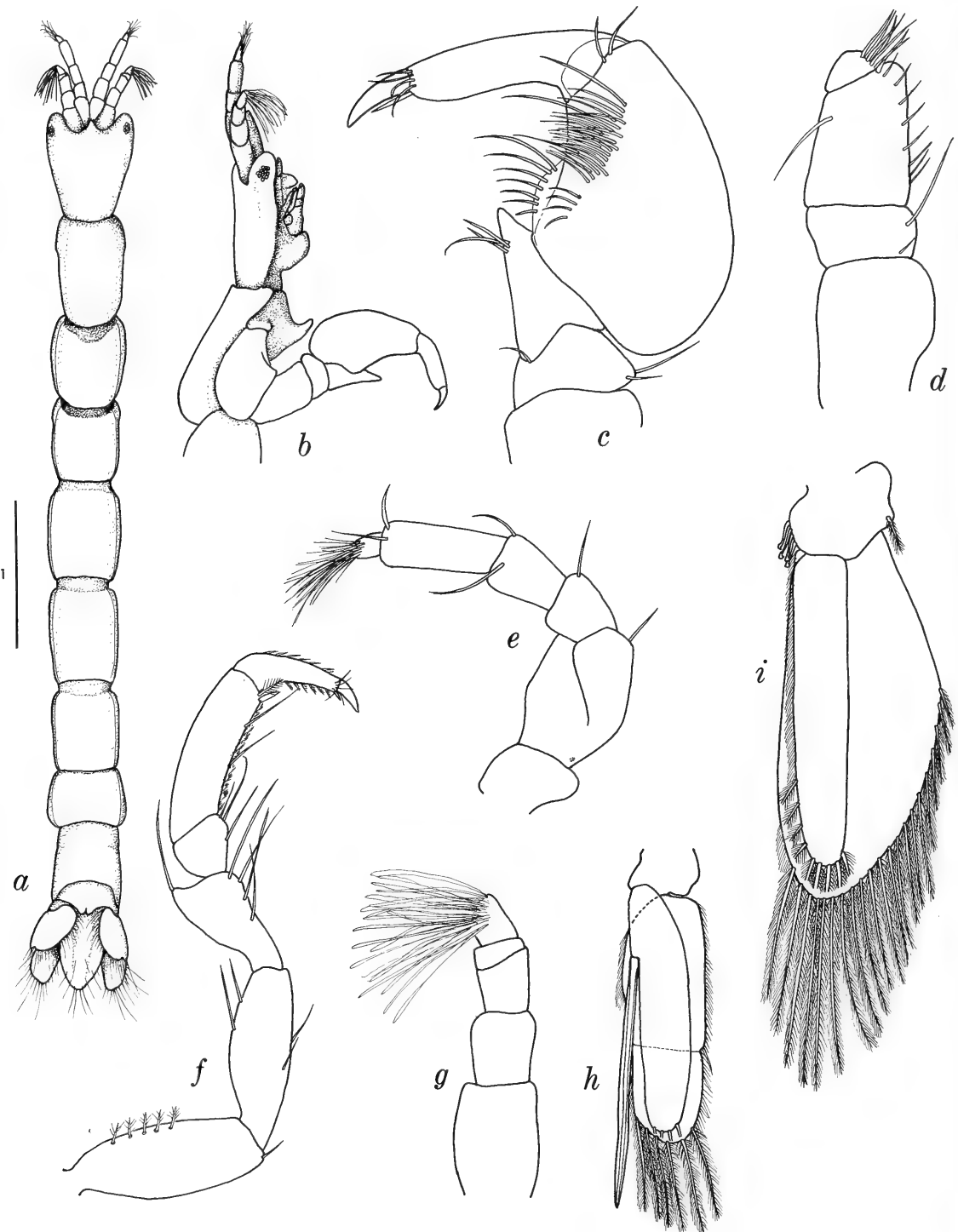


Fig. 5. *Skuphonura laticeps*: a, ♂ in dorsal view; b, ♂ Cephalon and pereonite 1 in lateral view; c, Pereopod 1 ♂; d, Maxilliped; e, Antenna; f, Pereopod 7; g, Antennule ♂; h, Pleopod 2 ♂; i, Pleopod 1.

segments together; flagellum article setose. Maxilliped 5-segmented, terminal segment short, obliquely set on penultimate segment, bearing 6 setae; 4th segment twice length of 3rd. Pereopod 1 unguis about one-third length of dactylus, latter with slight distal bulge at base of unguis; propodal palm concave, with numerous slender spines distally, membranous convexity proximally bearing 7 slender spines; carpus triangular, produced distally into narrowly triangular process. Posterior pereopods with carpus short, underriding propodus; propodus and dactylus bearing fringed scale-like spines on posterior margin. Pleopod 1 exopod operculiform, endopod slightly shorter and one-third width of exopod; basis with 4 retinaculae. Pleopod 2 endopod with straight apically acute appendix masculina, extending well beyond rami. Uropodal exopod oval, with distinct distal notch, fringed with setae; endopod almost reaching telsonic apex, distally rounded, bearing numerous setae.

*Type-material*.—Copenhagen Museum, syntypes 3 ♂, St. Thomas, West Indies, 8–40 m.

*Remarks*.—Barnard (1925) described this species from three males from St. Thomas in the West Indies, and one female from Tobago. The latter, however, has not been included in this discussion, as there is some doubt that it is the same species. The telsonic shape and the dactylus of pereopod 1 differs from the males, while in the two new species described below, the dactylus is similar in both species. The flagellum of the antennule in this female has two articles, while in both the new species the flagella are uniaarticulate. The female characters are thus omitted from the description of this species.

*Skuphonura itapuca*, new species

Figs. 6, 7

*Description*.—♂. Body proportions:  $C < 1 > 2 = 3 < 4 = 5 = 6 > 7$ . Cephalon anteriorly slightly wider than posteriorly; eyes present; lateral ridge well developed; medioventral toothlike process at base of mouthparts. Pereonites 4, 5, and 6 with faint proximal groove or constriction, becoming obsolete on pereonite 7 and pleon. Pleonites 1–5 fused, segments indicated ventrolaterally; pleonite 6 free, posterodorsal margin convex. Telson distally rounded, dorsally with slight proximal median ridge; 2 statocysts present; ventrally flattened.

Antennular peduncle 3-segmented, basal segment equal in length to 2 distal segments. Antennal peduncle 5-segmented, 2nd segment longest and widest, grooved to accommodate antennule. Mandibular palp 3-segmented, terminal segment about half length of middle segment, bearing 3 distal setae; incisor of 2 blunt cusps; molar of 2 rounded lobes, separated from incisor by 9-serrated lamina dentata. Maxilla slender, with 6 distal spines. Maxilliped



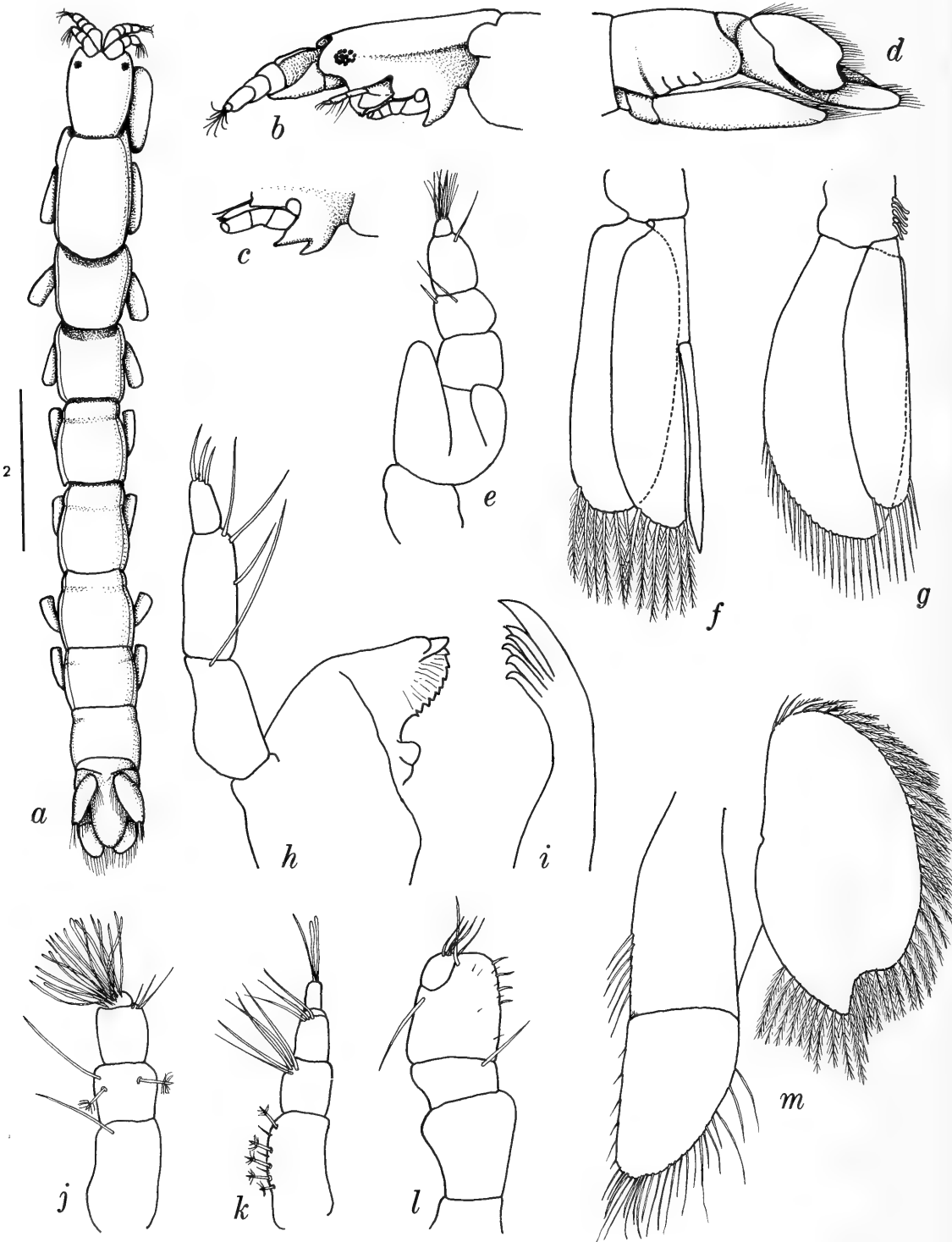


Fig. 6. *Skuphonura itapuca*: **a**, Holotype in dorsal view; **b**, ♂ Cephalon; **c**, ♀ Base of mouthparts; **d**, Pleon in lateral view; **e**, Antenna; **f**, Pleopod 2♂; **g**, Pleopod 1; **h**, Mandible; **i**, Maxilla; **j**, Antennule ♂; **k**, Antennule ♀; **l**, Maxilliped; **m**, Uropod.

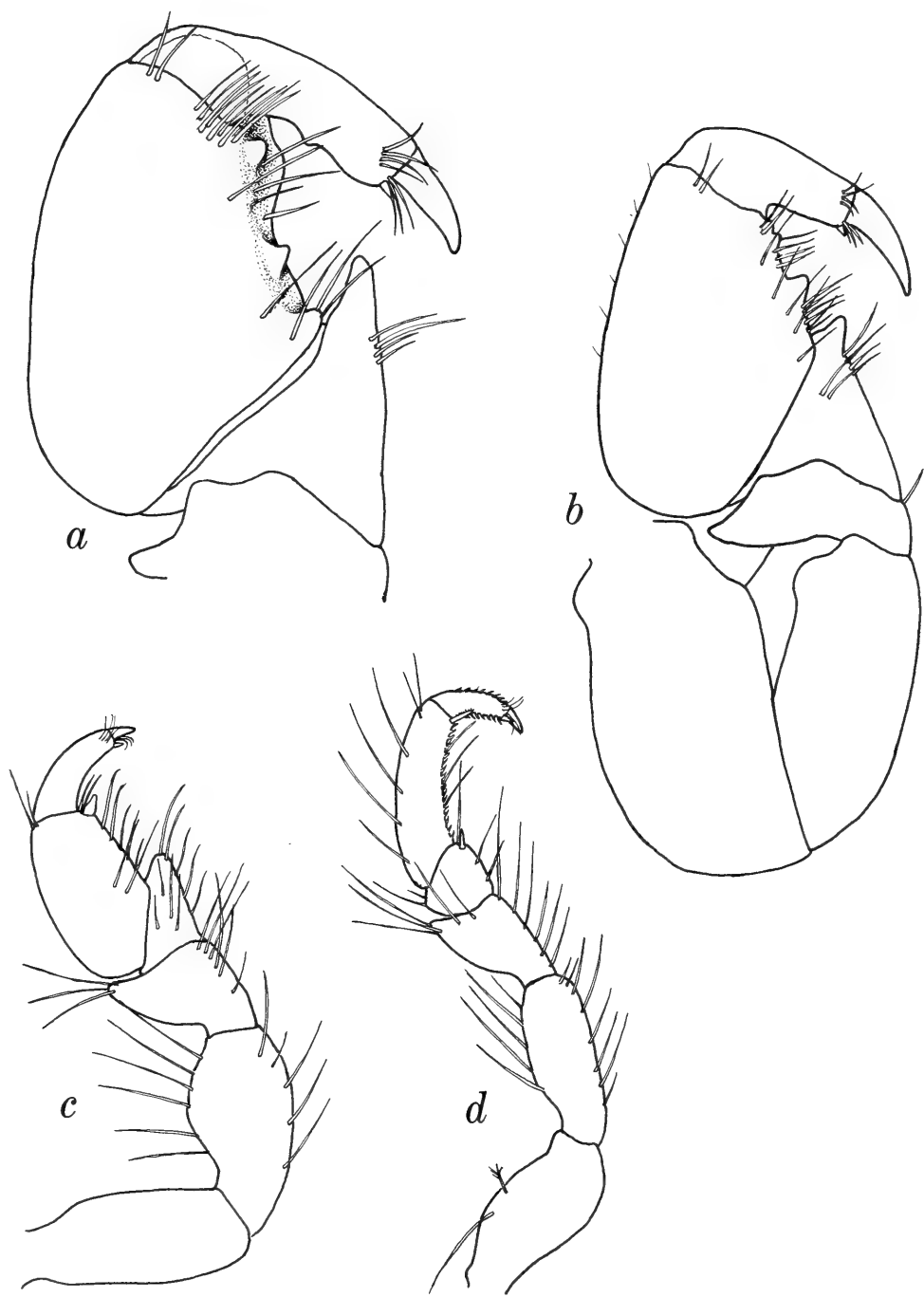


Fig. 7. *Skuphonura itapuca*: a, Pereopod 1 ♂; b, Pereopod 1 ♀; c, Pereopod 2; d, Pereopod 7.

5-segmented, outer margin of 3rd segment concave; distal segment short, inserted at outer angle of 4th segment. Pereopod 1 unguis one-third length of dactylus, with small spine at base; palm of propodus excavate, with 3 rounded tubercles on median edge, outer margin sinuous; carpus produced ventrodistally into narrowly triangular lobe. Pereopod 2 unguis one-quarter length of dactylus; propodus with short strong spine at ventrodistal corner;

carpus triangular, produced obliquely beneath propodus. Pereopods 4–7 dactylus with spinose scales; propodus cylindrical, with strong serrate spine at ventrodistal corner, ventral surface bearing short spinose scales; carpus triangular, underriding propodus, with strong ventrodistal spine; elongate setae on all segments. Pleopod 1 exopod operculiform, barely indurate, twice width and slightly longer than endopod; both rami with distal plumose setae; basis with 5 retinaculæ. Pleopod 2 endopod with stylet articulating at about midlength of median margin, slightly longer than ramus, distally broadened, apically acute; both rami with 6 distal plumose setae. Uropodal exopod slightly longer than basis, with distal notch, margin lined with plumose setae; endopod distally rounded, bearing simple setae.

♀. Medioventral process posterior to mouthparts with 2 strong toothlike spines. Antennular peduncle 4-segmented, segments 2 and 3 bearing elongate ventral setae; segment 4 short. Pereopod 1 propodal palm with median tooth and smaller distal tooth, proximal tooth not as developed as in ♂; carpus with ventrodistal triangular extension.

*Material examined*.—Nitheroy, Rio de Janeiro, Brasil, intertidal, collected by Dr. Waldo Schmitt in 1925. USNM 173522, Holotype ♂ TL 8.9 mm. USNM 173523, Allotype ♀ TL 9.3 mm. USNM 173524, Paratypes 9 ♀, 3 juveniles.

*Etymology*.—The specific name derives from the name of the beach at which the specimens were collected.

*Skuphonura ecuadorensis*, new species

Figs. 8, 9

*Description*.—♂. Integument indurate, brittle. Body proportions:  $C < 1 > 2 > 3 < 4 = 5 > 6 > 7$ . Cephalon broader distally than proximally, with anterolateral corners lobe-like and rounded, extending well beyond rostrum, bearing eyes of 6 or 7 small ocelli; lateral margin of cephalon forming a rounded ridge; small medioventral rounded tubercle posterior to mouthparts. Pereonites 4–6 with faint proximal constriction. Pleonites 1–5 fused, segments indicated ventrolaterally by short slits; pleonite 6 free, with mediodorsal slit in posterior margin. Telson lanceolate, ventrally flattened, dorsally with proximal area raised to rounded median ridge, spreading from about midlength to broad area sloping to rounded apex.

Antennular peduncle 3-segmented; flagellum of single article bearing cluster of filiform aesthetascs. Antennal peduncle 5-segmented, second segment longest and broadest, grooved to accommodate antennule; flagellum of single setose article. Mandibular palp 3-segmented, terminal segment one-third length of 2nd, with 3 distal setae; 1st and 2nd segments with elongate setae; incisor of 2 rounded cusps; molar of 3 rounded teeth; lamina dentata with 10–11 serrations. Maxilla slender, with 6 distal spines. Maxilliped 5-segmented, terminal segment situated at outer distal corner of 4th segment, 3rd segment

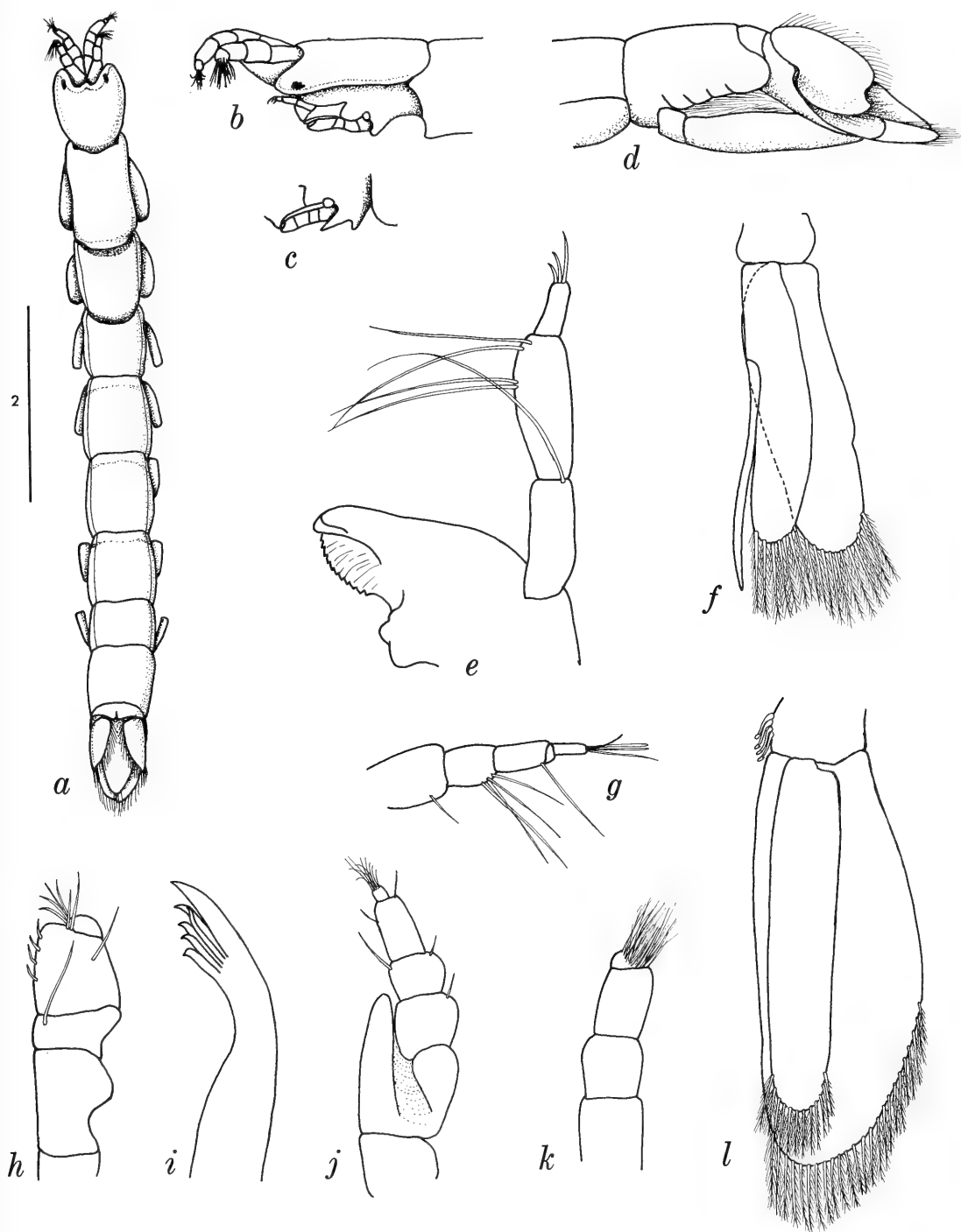


Fig. 8. *Skuphonura ecuadorensis*: a, Holotype in dorsal view; b, Cephalon ♂; c, ♀ Base of mouthparts; d, Pleon in lateral view; e, Mandible; f, Pleopod 2♂; g, Antennule ♀; h, Maxilliped; i, Maxilla; j, Antenna; k, Antennule ♂; l, Pleopod 1.

with concave outer margin. Pereopod 1 unguis one-third length of dactylus, with small supplementary spine and slight proximal concavity on ventral margin; propodal palm concave, with small distal and large proximal tooth-like tubercle; carpus distally narrowed into blunt tubercle. Pereopod 2 un-

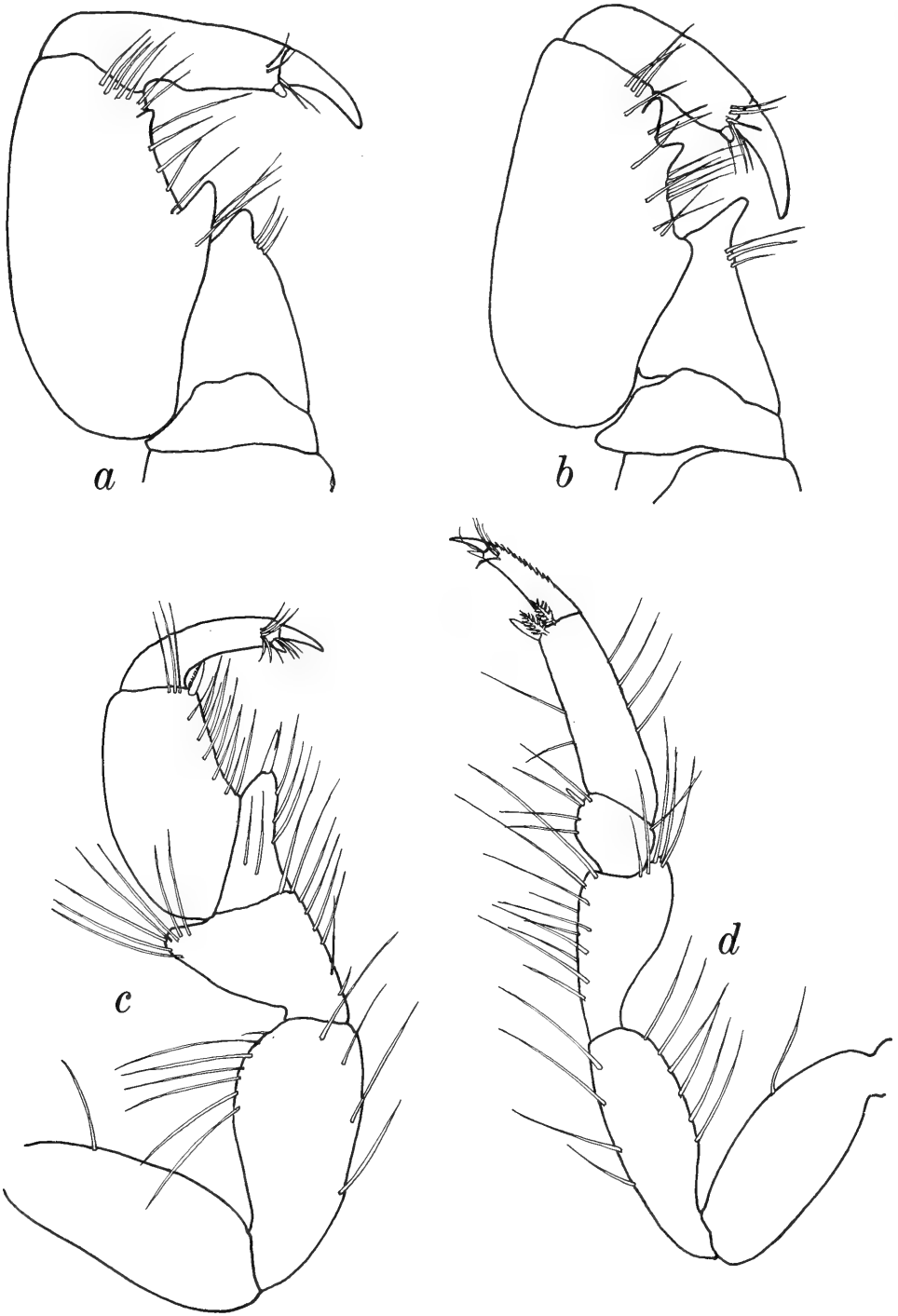


Fig. 9. *Skuphonura ecuadorensis*: a, Pereopod 1♂; b, Pereopod 1♀; c, Pereopod 2; d, Pereopod 7.

guis one-quarter length of dactylus; propodus with several ventral setae, strong spine at ventrodistal corner, serrate on one edge; carpus triangular, with sensory spine distally; merus and ischium bearing elongate setae. Pereopods 5–7 dactylus bearing short fringed scales; propodus cylindrical, with ventrodistal spine, serrated on one margin, and 2 spines serrated on both

margins; carpus short, underriding propodus; all segments with several elongate setae. Pleopod 1 exopod operculiform; endopod shorter than and slightly less than half width of exopod; both rami bearing distal plumose setae; basis with 4 retinaculae. Pleopod 2 copulatory stylet on endopod extending beyond rami, distally acute. Uropodal exopod with distal notch, fringed with plumose setae, not quite reaching endopod.

♀. Medioventral process posterior to mouthparts consisting of 2 tubercles. Antennular peduncle 4-segmented, 4th segment very short; flagellum of single article bearing 2 aesthetascs and few simple setae. Pereopod 1 with 2 toothlike tubercles on distal half of propodal palm; triangular carpus produced distally into toothlike projection.

*Material examined*.—La Libertad, Ecuador, intertidal. USNM 173525, Holotype ♂ TL 7.2 mm. USNM 173526, Allotype ♀ TL 7.2 mm. USNM 173527, Paratypes ♀ TL 7.2 mm, 2 juveniles.

*Etymology*.—The specific name derives from the country of origin of the species, viz. Ecuador.

*Remarks*.—*Skuphonura itapuca* and *S. ecuadorensis* seem to be closely related, judging from the many structural similarities, including the midventral cephalon process of the female, the antennules, antennae, mouthparts, pereopods 2–7, pleopods, and uropods. The main differences lie in the first pereopods of both the male and female, which show subtle differences in the size and placing of the toothlike tubercles of the propodal palm and carpus, the midventral cephalon process in the male, and the outline of the cephalon seen in dorsal view. *S. ecuadorensis* is markedly broader distally and the anterolateral lobes are more produced than in *S. itapuca*. The relationship between the 3 species of *Skuphonura* is difficult to assess. It is possible that a single species was distributed over the Caribbean-Central American region before the final emergence of the isthmus of Panama. Subsequent geological and hydrological events could have led to the isolation of 3 populations, giving rise to the present species.

The major differences between the 3 species are summarized in the following table.

	<i>S. laticeps</i>	<i>S. itapuca</i>	<i>S. ecuadorensis</i>
Pereopod 1♂	Carpus well produced Propodus with low convexity	Carpus well produced 3 short propodal spines	Carpus slightly produced Propodus with 1 large and 1 small spine
Pereopod 1♀	— —	Carpus slightly produced Propodus with large proximal and small distal spine	Carpus well produced Propodus with 2 distal spines

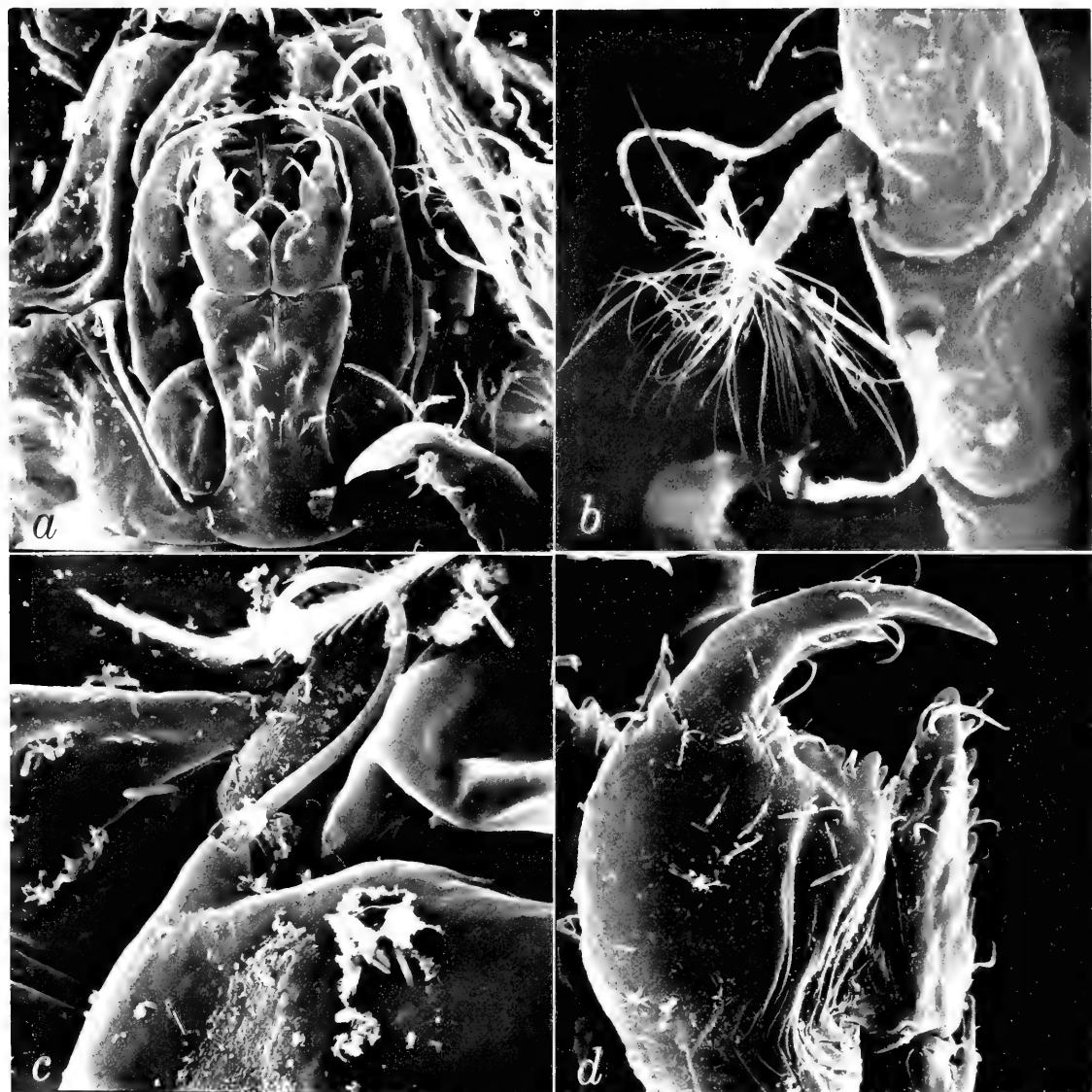


Fig. 10. *Xenanthura brevitelson*: **a**, Mouthparts in situ; **b**, Antennule showing robust sensory seta; **c**, Reduced mandibular palp; **d**, Pereopod 1.

Midventral cephalon process	♂	single, blunt	♂	single, conical	♂	single, blunt
	♀	—	♀	2 conical spines	♀	1 conical spine, 1 blunt tubercle
Pereonite 1		Strong medio-ventral spine		Spine lacking		Spine lacking

*Xenanthura brevitelson* Barnard  
Fig. 10

*Xenanthura brevitelson* Barnard, 1925:138, fig. 8.—Nierstrasz, 1941:240.—Pillai, 1963:263.—Menzies and Frankenberg, 1966:38, fig. 15.—Schultz, 1969:92, fig. 122.—Camp, Whiting, and Martin, 1977:16.

*Previous records.*—St. Thomas, West Indies, 50–60 m; Off Georgia, 20–145 m; Off Florida, 8–10 m.

*Type-material.*—The type-material of *X. brevitelson* from the Copenhagen Museum, collected by T. Mortensen, consists of three vials, each labelled 'Type'. One vial has a pencilled note in K. H. Barnard's autograph, a second has an inked label also in Barnard's autograph. North East of Hans Lollik (North of St. Thomas) 8 March 1906, Syntypes, 3 ♂, 1 sub ♂, 24 ♀, 5 juveniles. North East of Hans Lollik (North of St. Thomas) 50–60 m, 8 March 1906, Syntypes, 1 sub ♂, 8 ♀, 6 juveniles. St. Thomas, West Indies, 50–60 m, Syntypes 3 ♂ 3 ♀.

*Remarks.*—Figure 10b shows what Barnard (1925) mistook for a second flagellum on the antennule to be a large sensory seta, as was suggested by Menzies and Frankenberg (1966).

The presence amongst the syntypes of two submales with elongate antennules lacking aesthetascs along with fully mature males, suggests that *X. brevitelson* is another anthurid which displays protogyny, and that at least two molts are involved in the change from female to male.

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My sincere thanks are due to Mr. H. Kaufman for the Panama material, Mr. J. Vogel for the *Apanthura magnifica* material from Florida, Dr. Torben Wolff of the Zoological Museum, Copenhagen, for the loan of the *Skuphonura* and *Xenanthura* material, and especially to Dr. T. E. Bowman of the Smithsonian Institution, for reading the manuscript and for his valuable criticisms. I am grateful to Susann G. Braden and Mary-Jacque Mann of the Smithsonian Scanning Electron Microscope Laboratory, and Mr. M. Carpenter of the Department of Invertebrate Zoology, for the preparation of the micrographs used here.

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## ON THE CARAPACE SHAPE OF SOME EUROPEAN FRESHWATER INTERSTITIAL CANDONINAE (OSTRACODA)

Dan L. Danielopol

**Abstract.**—The interstitial Candoninae have a large number of species with trapezoidal triangular and widely arched carapace shapes. Some of the interstitial Candoninae display carapaces with extreme morphological features, e.g. a very elongate shape with a pointed posterior, a triangular shape with a large dorsal protuberance.

It is suggested that such species, as *Mixtacandona elegans* Danielopol & Cvetkov and *Phreatocandona motasi* Danielopol, with elongate carapaces and pointed posterior should have a low fecundity. The Candoninae species with this extreme type of carapace shape are known also from the sublittoral of Lake Baikal ("*Candona*" *fossiliformis* Mazepova) and from the eastern Paratethys during the Pliocene (*Pontoniella schemachensis* Mandelstam). It is hypothesized that the elongate carapace shape with a pointed posterior is an adaptation less suited for Candoninae living in unpredictable surface habitats but acceptable for those species inhabiting physically and/or biologically stable habitats which exist over geological epochs.

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### The Freshwater Interstitial Candoninae of Europe

The subfamily Candoninae (sensu Danielopol, 1976, 1978) contains a high number of true interstitial species living in freshwater habitats in Europe (Danielopol, 1977). This subfamily is also one of the most "species-rich" ostracod groups living in European surface waters (Löffler & Danielopol, 1978). The Candoninae are creeping forms with unpigmented carapace and eye.

I consider "true interstitial" ostracods to be species found in interstitial or in interstitial and cavernous aquatic habitats, which show eye reduction and/or long antennal aesthetascs "Y" (see Danielopol, 1973). In cases where data on these characteristics is not available, species recorded exclusively from the above mentioned habitats are referred to as "true interstitial" forms (Table 1). Several species are not included in this category because reliable data about their typical habitat is lacking (see Danielopol, 1978).

The carapace shapes of the interstitial Candoninae can be roughly classified as follows: a) almost rectangular; b) elongate, slightly triangular; c) widely arched dorsally; d) "highly" triangular; e) trapezoidal; f) elongate with pointed posterior. Table 1 presents data available for the interstitial

Table 1.—The freshwater interstitial Candoninae recorded in Europe (i—interstitial habitat; k—karstic habitat; a—almost rectangular; b—elongate, slightly triangular; c—widely arched dorsally; d—“highly” triangular; e—trapezoidal; f—elongate with pointed posterior). Data from Danielopol, 1978; Danielopol & Cvetkov, 1979; Sywula, 1976.

Taxa	Habitat	Shape	Height
<i>Pseudocandona</i>			
<i>eremita</i> (Vejdovsky) s.l.	i + k	d	>1/2
<i>zschokkei</i> (Wolf)	i	e	>1/2
<i>puteana</i> (Klie)	i	d	>1/2
<i>schellenbergi</i> (Klie)	i	e	>1/2
<i>triquetra</i>	i + k	d	>1/2
<i>belgica</i> (Klie)	i	e	>1/2
<i>hertzogi</i> (Klie)	i	e	>1/2
<i>brisiaca</i> (Klie)	i	c	>1/2
<i>insueta</i> (Klie)	i	e	<1/2
<i>bilobata</i>	i	c	>1/2
<i>spelaea</i> (Klie)	i + k	a	1/2
<i>dichtliae</i> (Brehm)	i	e	>1/2
<i>szöcsi</i> (Farkas)	i	d	>1/2
<i>bilobatoides</i> (Löffler)	i	c	<1/2
<i>pseudoparallela</i> (Löffler)	i	a	1/2
<i>profundicola</i> (Löffler)	i	a	1/2
<i>tyrolensis</i> (Löffler)	i	a	1/2
<i>altoalpina</i> (Löffler)	i	a	1/2
<i>rouchi</i> Danielopol	i + k	e	>1/2
<i>delamarei</i> Danielopol	i	a	>1/2
<i>Ps. n. sp. aff. eremita</i>	i	d	>1/2
<i>mira</i> Sywula	i	e	<1/2
<i>Cryptocandona</i>			
<i>phraeticola</i> (Klie)	i	b	<1/2
<i>leruthi</i> (Klie)	i	b	<1/2
<i>kieferi</i> (Klie)	i	b	<1/2
<i>juvavi</i> (Brehm)	i	b?	<1/2?
<i>matris</i> Sywula	i	b	>1/2
<i>Fabaeformiscandona</i>			
<i>latens</i> (Klie)	i	a	>1/2
<i>wegelini</i> Petkovski	i	a	<1/2
<i>Candonopsis</i>			
<i>boui</i> Danielopol	i	b	<1/2
<i>Phreatocandona</i>			
<i>motasi</i> Danielopol	i	f	<1/2
<i>Mixtacandona</i>			
<i>laisi</i> (Klie)	i	e	<1/2
<i>stammeri</i> (Klie)	i + k	e	<1/2
<i>chappuisi</i> (Klie)	i	e	<1/2
<i>transleithanica</i> (Löffler)	i	a	<1/2

Table 1.—Continued.

Taxa	Habitat	Shape	Height
<i>löffleri</i> Danielopol	i	e	>1/2
<i>botosaneanui</i> Danielopol	i	e	<1/2
<i>pietrosanii</i> Danielopol & Cvetkov	i	b	<1/2
<i>elegans</i> Danielopol & Cvetkov	i	f	<1/2
<i>Mixtacandona</i> n. sp.	i	d	>1/2
<i>Mixtacandona</i> sp. aff. <i>chappuisi</i>	i	e	<1/2
<i>pseudocrenulata</i> Schäffer	i + k?	e	<1/2
<i>cottarellii</i> n. sp. (in litt.)	i	e	<1/2
<i>juberthieae</i> Danielopol	i	e	<1/2
<i>Nannocandona</i>			
<i>stygia</i> Sywula	i	e	<1/2

Candoninae. Similar carapace shapes also exist in the surface-dwelling Candoninae (review in Danielopol, 1978).

Hartmann (1973) showed that among the marine creeping interstitial ostracods (mainly Cytheracea) the elongate carapace (height less than 1/2 the length) is most commonly found. From Table 1 one can see that 41% of the freshwater interstitial species have carapaces with maximal height of more than 1/2 the carapace length. One should notice too that the carapace shapes of many species are trapezoidal, “highly” triangular and dorsally widely arched. Some of the European interstitial Candoninae have carapaces with extreme morphological features. *Mixtacandona elegans* Danielopol & Cvetkov (Fig. 1A, B) from southeastern Bulgaria has the most dorsoventrally depressed and elongate carapace of all the Candoninae (Danielopol & Cvetkov, 1979). Two other subterranean Candoninae display similar carapace shapes, i.e. *Mixtacandona ljevuschkini* (Rudjakov) from a cave in Transcaucasia (Rudjakov, 1963) and *Phreatocandona motasi* Danielopol (Fig. 1C, D) from the southern Carpathians in Romania (Danielopol, 1980). *Mixtacandona* n.sp. (Fig. 1F) lives in the same habitat and area as *M. elegans*. This species has the largest dorsal protuberance occurring in the Candoninae, i.e. 1/4 the total height (Danielopol & Cvetkov, 1979). The only epigeic Candoninae I could find with similar extreme morphological characteristics is “*Candona*” *fossiliformis* Mazepova (Fig. 1E), a species which lives in the sublittoral of Lake Baikal between 20 and 50 m depth (Mazepova, 1970; Löffler, pers. comm.). This species has an elongate carapace with a pointed posterior. A similar species has been recorded by Mandelstam *et al.* (1962) and Vekua (1975) from the Pliocene deposits of the eastern Paratethys in the southwest of the Soviet Union (i.e. *Pontoniella schemaschensis* Mandelstam, Fig. 3B). This species lived in a shallow Caspi-brackish environ-

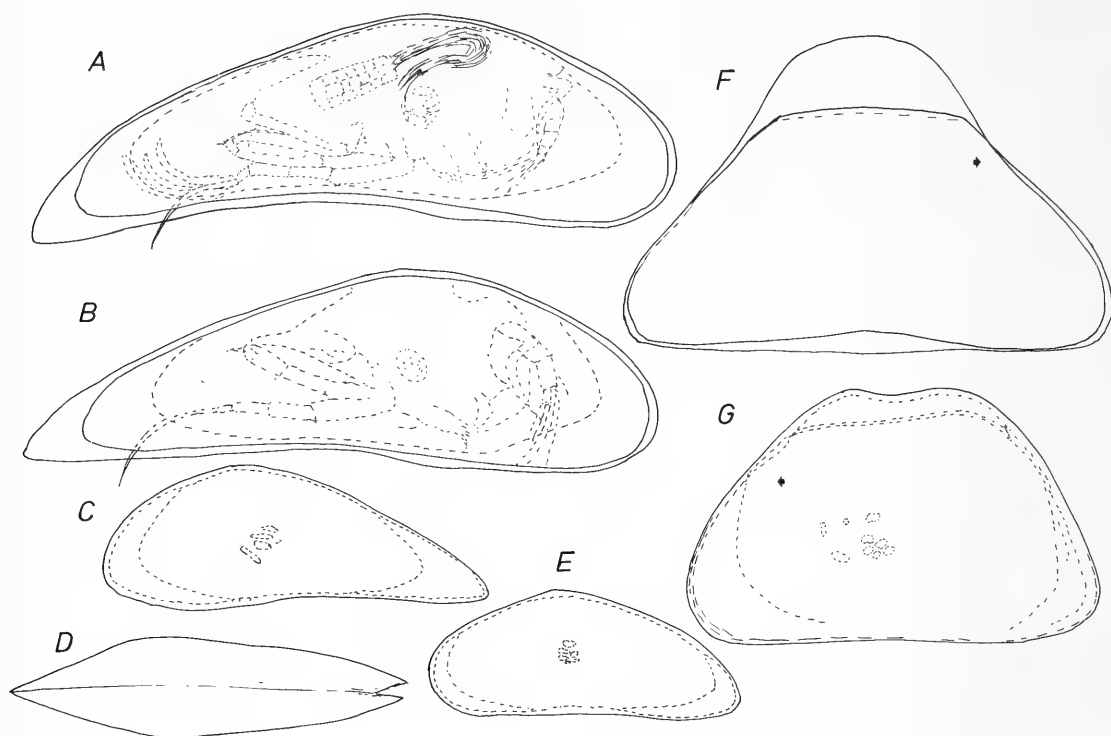


Fig. 1. A, B, *Mixtacandona elegans*, ♂ and ♀ carapaces (Zvetdetz); C, D, *Phreatocandona motasi*, ♀, (Jiblea); C, left valve; D, Carapace, dorsal view; E, "*Candona*" *fossiliformis* (Lake Baikal); F, *Mixtacandona* n. sp., ♀, (Zvetdetz); G, *Pseudocandona dorsoconcava*, ♀ (Lake Baikal).

ment. The specimen of *Pseudocandona dorsoconcava* (Bronstein) figured here (Fig. 1G) was found in Lake Baikal at 20 m depth. It has a very conspicuous dorsal protuberance ( $\frac{1}{7}$  of the total height located in the anterior half of the carapace). No other surface Candoninae has been recorded with such a high dorsal protuberance.

Mazepova (1970) suggested that "*Candona*" *fossiliformis* from Lake Baikal has phylogenetic affinities with the fossil species belonging to the *Candona* of the group *lobata* from the Paratethys and with the Recent "*Candona*" *ljovuschkini* from Transcaucasia. Danielopol & Cvetkov (1979) showed that "*Candona*" *ljovuschkini* belongs to the *Candona* group *mixta*, now considered a valid genus, *Mixtacandona* Klie (Danielopol, 1977/1978). This species has the 2nd thoracic leg with 2 short and 1 long distal setae, the clasping palps of the maxilla slightly asymmetric and with digitiform tips, characteristics that can be found in all the *Mixtacandona* species. *Mixtacandona ljovuschkini* has close affinities with *Mixtacandona elegans*. *Phreatocandona motasi* Danielopol has 3 short setae on the exopodite of the antenna, a long distal seta on the 1st thoracopod; the 2nd thoracopod is similar to those of *Pseudocandona*, having distally 3 long setae. In these

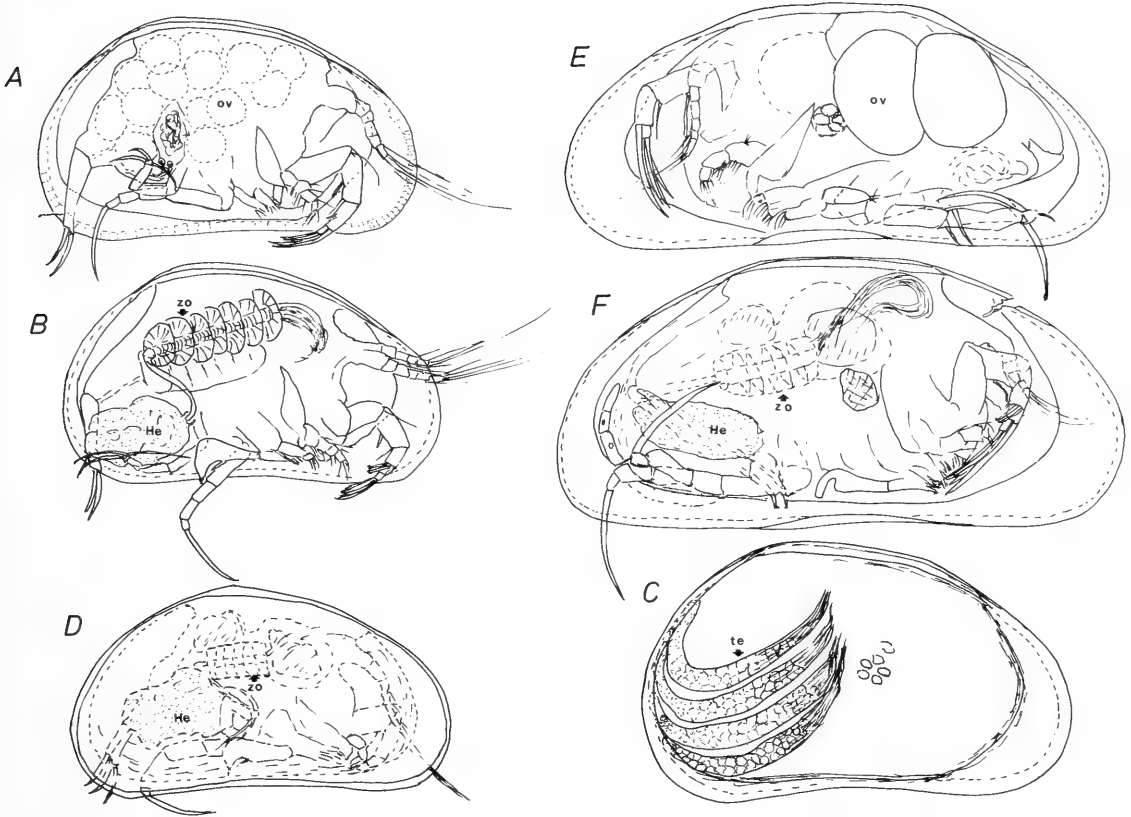


Fig. 2. Epigean (E) and hypogean (Hy) Candoninae: A, B, *Pseudocandona pratensis*, ♀, (E), (Dourdou); C, *Pseudocandona* aff. *pratensis*, ♂, (E). (Seewinkel, temporary pond nr. 12); D, *Pseudocandona* n. sp. aff. *eremita*, ♂, (Hy), (Jiblea); E, F, *Mixtacandona* aff. *chappuisi*, ♀, ♂, (Hy), (Bogdan Voda) (ov—ovocytes, zo—Zenker's organ, He—hemipenis, te—testes).

peculiarities *Phreatocandona* differs from other genera of Candoninae. “*Candona*” *fossiliformis* has the antennae, the clasping palps of the maxilla and the thoracopods similar to those of *Pseudocandona* species. These data suggest that the elongate carapace shape with an extremely pointed posterior, occurring in species found in both ground water (in Europe) and in Lake Baikal, was produced by parallel evolution in related phylogenetic lineages.

The Functional Importance of the Carapace Shape  
in the Candoninae

Why within the Candoninae does this characteristic carapace shape, very elongate and pointed, occur only in species which live in subterranean habitats, in Lake Baikal and in the Paratethys? To answer this question one has to understand, first of all, the functional importance of the carapace. Secondly one has to find what such different environments as the groundwater (in southeastern Europe), the eastern Paratethys Sea (e.g. during the Pliocene) and the sublittoral of Lake Baikal have in common.

Throughout the evolution of the Candoninae the different carapace shapes developed several times in the different phylogenetic lineages (Danielopol, 1978). Here I showed the example of the elongate carapace with pointed posterior. There is evidence to show that the almost rectangular, the slightly triangular, the trapezoidal shaped carapaces allow for the development of large internal organs: e.g. in the female the oviducts, which store commonly large numbers of ovocytes; and in the male the seminal vesicles, the Zenker's organ with long spikes and the hemipenes, with well developed internal and external processes. Figure 2 shows such examples. The surface dwelling Candoninae with more or less rectangular carapaces like *Candona dancaui* Danielopol, *Candona angulata* G. W. Müller, *Pseudocandona pratensis* (Hartwig), *Pseudocandona albicans* (Brady), *Pseudocandona marchica* (Hartwig), display high fecundity (Danielopol, 1980). During the beginning of the reproductive period the females have the ability to store the ovocytes in the oviducts (Fig. 2A). One can find in some species like *Ps. pratensis* up to 20 ovocytes on each side stored in the lateral and the dorsal parts of the body. In the parthenogenetic species like *Ps. albicans* (Fig. 3A) the eggs are laid abruptly without fertilization. In the Candoninae the surface area and also the volume of the central and posterior parts of the carapace show marked interspecific differences. McGregor & Kesling (1969) computed the surface area in lateral view of a large number of Candoninae. To permit a comparison they expressed the data in terms of converted areas of the carapace using the following formula

$$Ca^{CA} = \frac{CA}{(L^{CA})^2} \times 100$$

where  $Ca^{CA}$  is the converted area, CA is the area of the carapace in lateral view,  $L^{CA}$  is the maximal length of the carapace. Table 2 (part A) shows the converted areas of several epigeic Candoninae (females) living in shallow water bodies. The second part (B) of the table shows the values for the 4 species with elongate carapace shape and pointed posterior. The latter group has the lowest values. Kesling (1965) and McGregor & Kesling (1969) pointed out that the interspecific differences in the converted areas are due to differences in the shape of the posterior part of the carapace which holds the reproductive organs. Table 3 supports this idea. It shows the converted area of the anterior  $\frac{1}{3}$  and of the posterior  $\frac{2}{3}$  of the carapace (see also Fig. 3B), calculated by the following:

$$Ca^A = \frac{A}{(\frac{1}{3} L^{CA})^2} \times 100 \quad \text{and} \quad Ca^P = \frac{P}{(\frac{2}{3} L^{CA})^2} \times 100$$

$Ca^A$  and  $Ca^P$  are the converted areas respectively of the anterior  $\frac{1}{3}$  and the posterior  $\frac{2}{3}$  of the carapace, A and P are areas of the respectively anterior

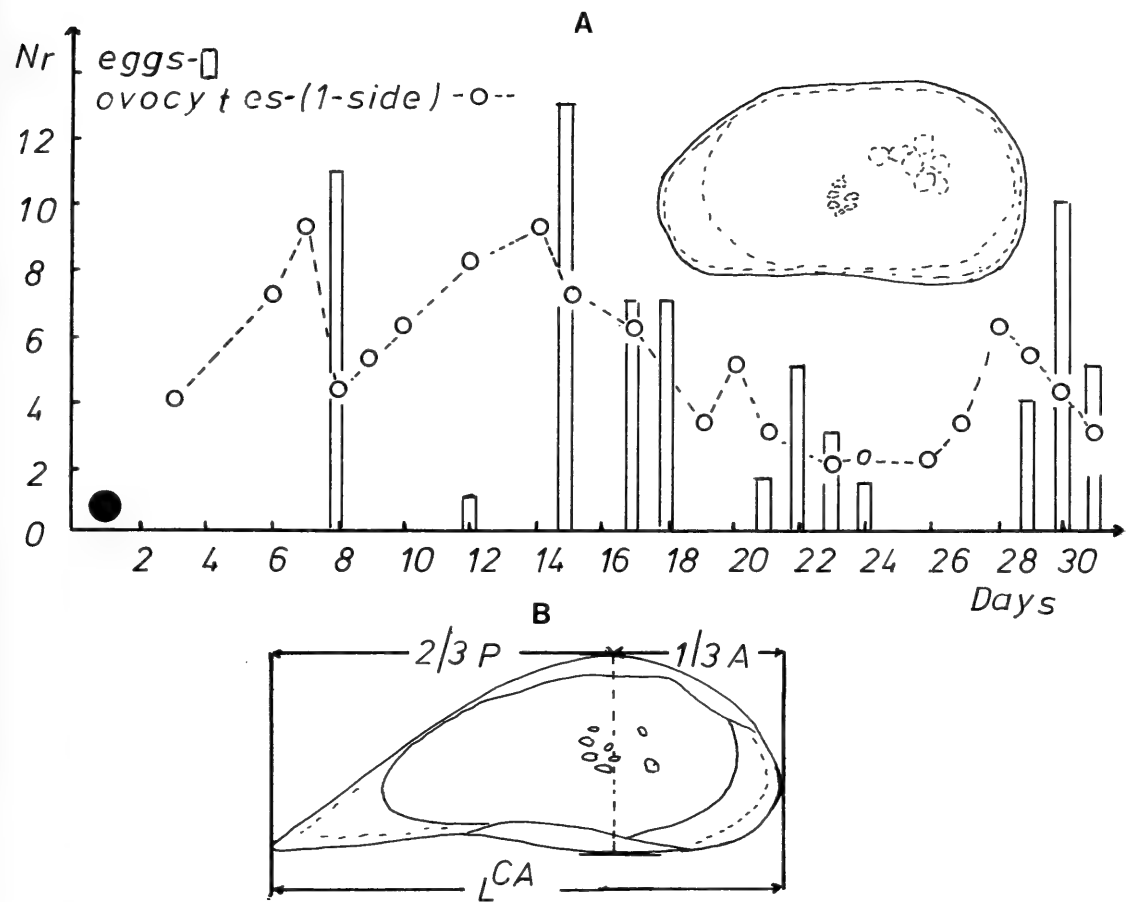


Fig. 3. A, *Pseudocandona albicans*, ♀, the evolution of the ovocyte number in the oviduct and the egg laying rhythm (●—the last molt); B, *Pontoniella schemachensis*, left valve (after Vekua, 1975).

1/3 and the posterior 2/3 carapace in lateral view. L<sup>CA</sup> is the maximal length of the carapace. Whereas the converted area of the anterior part varies within a narrow range, that of the posterior 2/3 varies to a larger extent. All the epigean Candoninae listed here have almost rectangular, elongate, slightly triangular, “highly” triangular and trapezoidal carapaces. Most of these species are widely arched posteriorly. The male copulatory organ as well as the clasping organs are normally held in the inner carapace space, i.e. within the space limited by the inner margin of the carapace (Fig. 2B, D, F).

A comparative study has been made in the following 21 Candoninae species of the area of the inner carapace space (ICA), excluding the calcarous lamellar area, and of the lateral surface area of the hemipenis (HeA) (Fig. 4A): 1. *Mixtacandona elegans* (Hy), 2. *M. laisi vindobonensis* (Hy), 3. *M. pietrosani* (Hy), 4. *Mixtacandona* sp. aff. *chappuisi* (Hy), 5. *M. löffleri* (Hy), 6. *M. cottarellii* n. sp. (Hy), 7. *M. tabacarui* (Hy), 8. *Can-*



Table 2.—Converted areas of equivalent carapaces (lateral view) in female Candoninae. Data compilation from Danielopol, 1978; Danielopol & Cvetkov, 1979; Delorme, 1970; Furtos, 1933; Hoff, 1944; Klie, 1938; Mazepova, 1970; McGregor & Kesling, 1969; Vekua, 1975. (**Ba**—Lake Baikal; **Eu**—Europe; **H**—Holarctic realm; **NA**—North America; **P**—Palearctic realm; **d**—ditches; **gw**—interstitial groundwater; **ll**—littoral lakes; **m**—marshes; **pp**—permanent ponds; **rp**—rock pools; **sc**—shallow channel; **tp**—temporary ponds; **tr**—temporary running water; **s**—sub-littoral; **sl**—shallow lakes).

Taxa	Converted area (%)	Distribution
<b>A.</b>		
<i>Candona mülleri</i> Hartwig	63.2	Eu—tp
" <i>C.</i> " <i>renoensis</i> Gut. & Bens.	48.8	NA—tp
<i>C. weltneri</i> Hartw.	46.6	Eu—ll, tp
<i>C. candida</i> (O.F.M.)	44.4	H—ll, pp, tp, d
" <i>C.</i> " <i>neglecta</i> Sars	43.7	P—d, m, ll, pp, tp, tr
" <i>C.</i> " <i>truncata</i> Furt.	43.6	NA—m, pp, tp
<i>Pseudocandona sucki</i> (Hartw.)	42.4	Eu—tp
<i>C. angulata</i> G. W. Müll.	42.5	Eu—ll, tp
" <i>C.</i> " <i>distincta</i> Furt.	41.6	NA—m, sc, sl
<i>Fabaeformiscandona hyalina</i> (Br. & Rob.)	40.8	Eu—m, ll, sl
" <i>C.</i> " <i>scopulosa</i> Furt.	39.4	NA—m, rp
" <i>C.</i> " <i>eriensis</i> Furt.	39.3	NA—ll, rp
" <i>C.</i> " <i>acuta</i> Hoff.	39.3	NA—tr
<i>F. fabaeformis</i> (Fisch.)	38.3	P—ll, tp
<i>F. acuminata</i> (Fisch.)	37.6	H—ll, tp
<i>F. fragilis</i> (Hartw.)	36.0	Eu—ll, tp
" <i>C.</i> " <i>ohioensis</i> Furt.	33.8	NA—ll
<b>B.</b>		
<i>Phreatocandona motasi</i> Dan.	27.0	Eu—gw
" <i>C.</i> " <i>fossiliformis</i> Mazep.	25.5	Ba—s
<i>Mixtacandona elegans</i> Dan. & Cvetk.	22.9	Eu—gw
<i>Pontoniella schemachensis</i> Mand.	20.1	Paratethys

*donopsis kingsleii* (E), 9. *C. boui* (Hy), 10. *Pseudocandona compressa* (E), 11. *Ps. simililampadis* (Hy), 12. *Pseudocandona* n. sp. aff. *eremita* (Hy), 13. *Ps. pratensis* (E), 14. *Ps. rouchi* (Hy), 15. *Ps. delamarei* (Hy), 16. *Ps. brevipes* (E), 17. *Fabaeformiscandona fabaeformis* (E), 18. *Candona weltneri* (E), 19. *C. dancaui* (E), 20. *C. fasciolata* (E), 21. *C. neglecta* (E).

The correlation between the converted areas of the inner carapace space ( $Ca^{ICA}$ ) and the lateral area of the hemipenis ( $Ca^{HeA}$ ) have been computed (Fig. 4A). There is a significant correlation ( $P < 0.05$ ) but the coefficient of determination ( $r^2$ ) is only 0.253. This means that only 25% of the variation in one of the 2 variables is explained by the other variable, therefore there is not a close relationship. It is suspected that the large hemipenis processes improve the success of the copulation due to a better sensorial contact with

Table 3.—Converted areas of the anterior (Ca<sup>A</sup>) and posterior carapace (Ca<sup>P</sup>) sides in several epigean (E) and hypogean (Hy) Candoninae species (see also explanation in Table 2).

Taxa	Ca <sup>A</sup>	Ca <sup>P</sup>	Distribution
<i>Pseudocandona</i>			
<i>Ps. albicans</i> (Br.), ♀	77	89	H—(E),ll,m,rp,tp,tr
<i>Ps. compressa</i> (Koch), ♀	77	93	H—(E),ll,tp
<i>Ps. n. sp. aff. eremita</i> , ♂	76	88	Eu—(Hy),gw
<i>Fabaeformiscandona</i>			
<i>F. fabaeformis</i> (Fischer), ♀	78	118	P—(E),ll,tp
<i>Candonopsis</i>			
<i>C. kingsleii</i> Br. & Rob., ♀	78	106	H—(E),ll,sc,sl
<i>Mixtacandona</i>			
<i>M. aff. chappuisi</i> , ♂	76	87	Eu—(Hy),gw
<i>M. pietrosanii</i> Dan. & Cvetk., ♀	73	91	Eu—(Hy),gw
<i>M. tabacarui</i> Dan. & Cvetk., ♂	76	86	Eu—(Hy),gw
<i>M. elegans</i> Dan. & Cvetk., ♀	78	32	Eu—(Hy),gw
♂	76	32	Eu—(Hy),gw
<i>Phreatocandona</i>			
<i>Ph. motasi</i> Dan., ♀	84	38	Eu—(Hy),gw
“ <i>Candona</i> ”			
“ <i>C.</i> ” <i>fossiliformis</i> Mazep., ♀	83	38	B—s
<i>Pontoniella</i>			
<i>P. schemachensis</i> Mand.	76	32	Paratethys

the genital lobes of the female (Danielopol, 1980). I also noticed marked differences in the development of Zenker’s organ of several Candoninae belonging to the genera *Mixtacandona*, *Candona*, *Pseudocandona*, *Fabaeformiscandona* and *Candonopsis*, which have high carapace shapes (height more than ½ the length). These species also have large Zenker organs. However, I did not find any significant correlation between the width of Zenker’s organ and the maximum height of the inner carapace space (Fig. 4B).

Relationship between the Carapace Shape and the Environment

Most of the epigean Candoninae listed in Tables 2 and 3 are species with almost rectangular, elongate, slightly triangular carapace shapes. These species are widespread in the Holarctic realm. They live commonly in shallow water bodies which are strongly dependent on the climatic changes of the atmosphere (Klie, 1938; Löffler & Danielopol, 1978; Bronstein, 1947; Delorme, 1970; Furtos, 1933; Hoff, 1942). Such habitats are physically unstable and

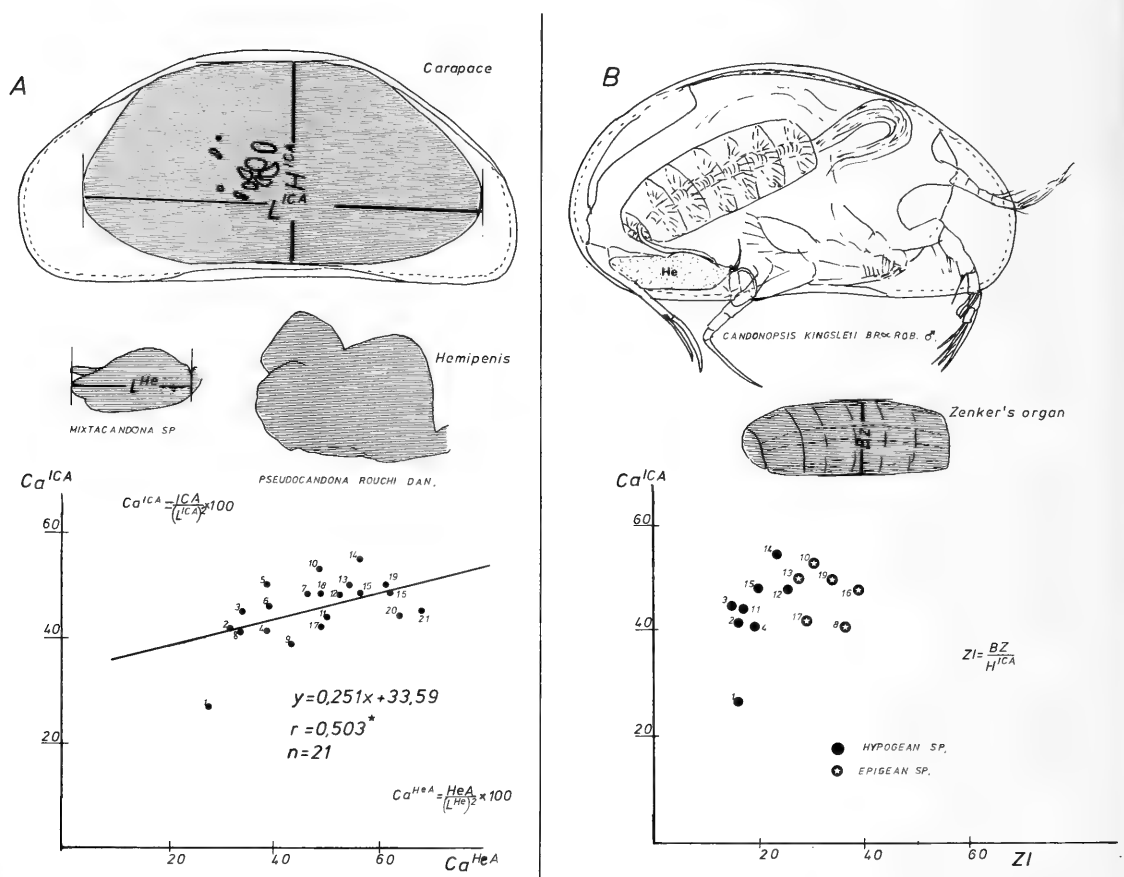


Fig. 4. **A**, Regression of area of inner carapace space upon lateral area of the hemipenis, with their statistical correlation (see also text); **B**, Relationship between the width of Zenker's organ and the maximum height of the inner space. (The numbers refer to the 21 species mentioned in the text.)

unpredictable. Some of them are short-lived habitats such as temporary ponds, ditches, rock pools, and temporary streams. A great success in reproduction and a high fecundity are at a premium for animals living in unstable water bodies (Southwood, 1976). Comparing the shape of the anterior and posterior part of the carapace of *Mixtacandona elegans*, *Phreatocandona motasi*, "*Candona*" *fossiliformis* and *Pontoniella schemachensis* (Table 3, Fig. 1A, B, C, E), one will notice that the anterior  $\frac{1}{3}$  is highly similar to the other Candoninae quoted above whereas the posterior part is very narrow. These morphological features suggest that the fecundity of these species is low. Further field and laboratory evidence should confirm this prediction.

*Mixtacandona elegans* Dan. & Cvetk. was found in a well from Zvezdets in southeastern Bulgaria near the border with Turkey (Danielopol & Cvetkov, 1979). *Phreatocandona motasi* was found in a well from Jiblea, near Calimanesti, in the Olt Valley in the southern Carpathians, in Romania

(Danielopol, 1979a). Whereas the short-term temperature fluctuations of the atmosphere in Europe cause thermic fluctuations in the shallow surface water bodies, they have only slight impact on the groundwater. For instance, Kriz (1973) showed that in southern Slovakia the maximum amplitude of the temperature in a well supplied by a shallow aquifer between 1933 and 1970 was only 0.2°C. Moreover, whereas high temperature or severe droughts can easily lead to the desiccation of restricted shallow water bodies above ground, they will affect a groundwater aquifer to a lesser extent, only by modifying its boundaries. These arguments suggested to me that the groundwater habitats of *Mixtacandona elegans* and *Phreatocandona motasi* are physically more stable compared to the epigeal shallow water bodies. If one considers the geographical position of the localities where *M. elegans* and *Ph. motasi* occur one will notice that they are situated on or near old land masses which have existed at least since the beginning of the Neogene (for Bulgaria data see Cvetkov, 1975 and Lüttig & Stephens, 1976; for Romania see maps in Decou & Negrea, 1969). This suggests that the aquifers in the southern Carpathians and in southeastern Bulgaria could have a very long span (millions of years). Lake Baikal is one of the oldest lakes; it has existed at least since the beginning of the Neogene, and according to Kozhov (1963) may have existed since the Oligocene. "The emergence of Baikal as a deep lake with borders approximately of their present shape is dated by Dumitrashko to the end of the Pliocene . . . ." (Kozhov, 1963:270). The sublittoral of Lake Baikal is also a stable environment highly similar to the groundwater habitats. Kozhov (1963:194) mentioned: "The water of the bottom layer in the sublittoral is subjected to much weaker seasonal temperature fluctuations than the littoral. At a depth of 50 m the annual amplitude of temperature fluctuations does not exceed 5–6°C. The influence of turbulence is practically imperceptible. Light intensity is insufficient for the development of macrophytes . . . ." In the sample received from Prof. Löffler, collected at 20 m depth in the Baikal, I found besides "*Candona*" *fossiliformis* 8 other endemic species of Candoninae, 4 endemic *Cytherissa* species and a remarkable Cytherid. I could not find any cosmopolitan Siberian ostracod species. This is in keeping with the data reported by Bronstein (1939, 1947) and suggests that in the sublittoral of Lake Baikal the ostracod association is a highly biologically accommodated community where each species has a narrow niche.

During the Pliocene in the central and eastern Paratethys a diverse endemic Candoninae fauna developed (Hanganu & Papaianopol, 1976; Krstic, 1972; Marinescu & Olteanu, 1973/1974; Sokac, 1972; Vekua, 1975, etc.) which recall those of Lake Baikal. From the data presented by the above mentioned authors it seems that there are few cosmopolitan Candoninae dwellers in the Paratethys. This suggests that the Pliocene ostracods from

the Paratethys were also species with good competitive possibilities. The endemic Caspi-brackish fauna prospered for several millions of years. Vekua (1975) showed that *Pontoniella schemachensis*, a species with elongate carapace and pointed posterior, lived during the Pontian, Klimmerian and Kuyalnikian in the eastern Paratethys. That means that the species was present there for more than 2.5 million years (using the paleomagnetic time scale proposed by Kochegura & Zubakov, 1978).

### Conclusion

From these data I hypothesize that within the group of Candoninae the elongate carapace shape with a pointed posterior is less suited for widespread species living in unstable surface habitats, but acceptable for species living in physically and/or biologically stable habitats which exist over geological epochs.

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Prof. H. Löffler (Vienna) offered the ostracods from Lake Baikal used in this paper. Dr. F. Schiemer (Vienna) and Dr. D. Keyser (Hamburg) criticized parts of this paper presented as a poster lecture at the 3rd International Meiofauna Conference in Hamburg, 1977. Mr. A. Gunatilaka (Vienna), Dr. H. J. Oertli (Pau) and an unknown colleague reviewed the manuscript. Concerning the Paratethys Candoninae I am much indebted for discussions and/or material to Dr. R. Benson (Washington D.C.), Dr. E. Hanganu (Bucharest), Dr. M. Krstic (Belgrade), Dr. R. Olteanu (Bucharest) and Dr. M. Stancheva (Sofia). Dr. H. J. Oertli (Pau), Dr. M. Gramm (Vladivostock), Dr. I. Neustrueva (Leningrad), Dr. M. Vekua (Tbilisi) and Dr. N. Grekoff (Paris) helped with bibliographical information.

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### Addendum

After sending the manuscript to the publisher, Dr. L. Ram (Zoological Survey of India, Patna) sent me the description of a new Candoninae with elongate carapace and pointed posterior. The Indian species lives in groundwater from Bihar.

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THE SUBSPECIES OF GRASSHOPPER SPARROW  
(*AMMODRAMUS SAVANNARUM*) IN PANAMÁ  
(AVES: EMBERIZINAE)

Storrs L. Olson

*Abstract.*—A specimen of *Ammodramus savannarum pratensis* from Almirante, Bocas del Toro, is the first record for Panamá and the southernmost known for this migrant subspecies. A very pale resident population, *A. s. beatriceae* subsp. nov., restricted to the llanos of Coclé Province, is described. A disjunct population in eastern Panamá Province is referable to *A. s. bimaculatus* of Middle America.

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The Grasshopper Sparrow, *Ammodramus savannarum*, is a secretive, though widely distributed, grassland finch found in most of North America and the Greater Antilles (except Cuba), through Middle America as far as Panamá, with two subspecies isolated in Curaçao and Bonaire and in Colombia and Ecuador. In Panamá, the species is poorly known and there is little in the literature concerning it. Material in the National Museum of Natural History, Smithsonian Institution (USNM), indicates that three distinct subspecies may be found in Panamá, one of which is a migrant and two of which are resident. Of the last two, one represents a very distinct new taxon.

*Ammodramus savannarum pratensis* (Vieillot)

*Fringilla pratensis* Vieillot 1817, Nouv. Dict. Hist. Nat., nouv. ed. 25:24.  
Type-locality, New York.

*Specimens examined.*—PANAMA. BOCAS DEL TORO: Almirante. An unsexed adult taken in November 1963 by personnel of the Gorgas Memorial Laboratory (USNM 533402).

*Remarks.*—This specimen is readily separated from any of the resident populations of *Ammodramus savannarum* in Middle America by its greater wing length (63.4 mm vs. 53.2–59.1 mm for *A. s. bimaculatus*,  $n = 23$ ). It is darker and more richly colored than the birds of western North America (*A. s. perpallidus* [Coues]), but is inseparable from individuals of *A. s. pratensis*, the migratory population breeding in eastern North America. The present specimen marks a significant range extension, the southernmost occurrence of the subspecies heretofore being in Belize (British Honduras). Ridgely (1976:339) mentions a specimen of this species that was captured



and released, also at Almirante, on 4 November 1967. He suggested that this was a migrant, which seems likely in view of the identity of the above specimen and the general lack of sufficient habitat in the Almirante area to sustain a breeding population of this species.

*Ammodramus savannarum bimaculatus* Swainson

*Ammodramus bimaculatus* Swainson 1827, Philos. Mag. (n.s.) 1(6):435.

Type locality, Temiscaltiepec (=Temascaltepec), Mexico.

*Specimens examined*.—PANAMA. CHIRIQUI: Francés (4, AMNH). PANAMA PROVINCE: Río Pacora, 10 miles W of Chepo (2, USNM, one of which is juvenile); 10 miles NW of Chepo (1, USNM).

*Remarks*.—The specimens from the Chepo area have been discussed fully by Aldrich (1945), who assigned them to the subspecies *bimaculatus*, which ranges from Mexico to Chiriquí, Panamá. I concur in this and have little to add to Aldrich's account. The Chepo birds are inseparable from Costa Rican specimens in fresh plumage, though I am not prepared to say that these in turn are the same as Mexican birds, as those Mexican specimens available to me were in quite worn plumage. The birds from Chepo, which is in the eastern extreme of the Pacific slope savannas of Panamá Province, certainly represent a breeding population, as evidenced by the juvenile specimen. Considering their apparent isolation from the nearest known population of *bimaculatus* in Chiriquí, it is somewhat curious that these birds have not differentiated, particularly in light of the distinctiveness of the birds from the savannas of Coclé, described below.

*Ammodramus savannarum beatriceae*, new subspecies

*Holotype*.—USNM 477168, female, taken 10 March 1962 by Alexander Wetmore at El Coco, Coclé Province, Panamá (original number 24894).

*Characters*.—Palest of all the subspecies of *A. savannarum*. Equal in size to *A. s. bimaculatus* but throat, breast, flanks and undertail coverts pale pinkish buff, not rich ochraceous yellow. Dorsum much grayer than in *bimaculatus* and median crown stripe very pale, almost white, instead of deep buff. The subspecies *A. s. cauae* Chapman, of Colombia and Ecuador, is also separable from *bimaculatus* by its paler coloration, but *beatriceae* is paler still. In a series of seven specimens of *cauae* from Yumbo, Department of Valle, Colombia (CM), the streaks in the nape are dark, rather blackish brown, never as distinctly reddish as in *beatriceae* or *bimaculatus*. The single available specimen of *A. s. caribaeus* (Hartert) from Curaçao (USNM), is also rather pale, but is more ochraceous on the breast and cheeks, more brownish above, and has a decidedly smaller bill than *beatriceae*.

*Range*.—Known only from the savannas of southern Coclé Province, Pacific slope of Panamá.

*Specimens examined (all USNM)*.—PANAMA. COCLE: El Coco (2); 4 miles W of Penonomé (2); Penonomé, Puerto Posada (1); Gago, Gaucho (1); 3 miles NW of Anton (4).

*Etymology*.—Affectionately dedicated to Mrs. Alexander Wetmore, who accompanied her husband on most of his collecting trips to Panamá and who attended him with unselfish devotion through their 25 years of marriage.

*Remarks*.—As this is perhaps the most easily distinguished of all the forms of *Ammodramus savannarum*, it is indicative of a fair degree of isolation of the grassland birds of the llanos of Coclé. Further evidence of this is supplied by another endemic subspecies of Emberizinae, *Sicalis luteola eisenmanni*, described by Wetmore (1953) from most of the same localities as *A. s. beatriceae*. This is the only population of *S. luteola* occurring between Guatemala and Colombia.

Acknowledgments

I am grateful to Kenneth C. Parkes, Carnegie Museum of Natural History (CM), Pittsburgh, for lending specimens of *A. s. caucaae* and for commenting on the manuscript. This is contribution Number 4 of the Wetmore Papers, a project supported in part by trust funds from the Smithsonian Institution for completing unfinished work and study of undescribed material left by the late Alexander Wetmore.

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*SPONGICOLOIDES GALAPAGENSIS*, A NEW SHRIMP  
REPRESENTING THE FIRST RECORD OF THE  
GENUS FROM THE PACIFIC OCEAN  
(CRUSTACEA: DECAPODA: STENOPODIDEA)

Joseph W. Goy

*Abstract.*—A new species of stenopodidean shrimp from the Galapagos Islands is described and figured. It is the first species of the genus *Spongiocoloides* Hansen recorded from the Pacific Ocean. The new species, *Spongiocoloides galapagensis*, is closely related to *S. profundus* and in a few characters is very similar to the genus *Spongiocaris* Bruce and Baba, but is easily distinguished from both by differences of the telson, spination of the carapace, and branchial formula. A table of some morphological differences for the known species of *Spongiocoloides* is included.

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The four known species of *Spongiocoloides* are from the Atlantic Ocean from Iceland to the Caribbean (Holthuis, 1946). While examining some unidentified stenopodid material from the National Museum of Natural History, Washington, D.C., I found a single example of an undescribed *Spongiocoloides*, collected by the steamer *Albatross* in deep water off the Galapagos Islands. In addition to its geographical location, several morphological characters also distinguish this specimen from the other members of the genus.

*Spongiocoloides galapagensis* sp. nov.

Figs. 1-4

*Material examined.*—1 ♀, ovigerous, Galapagos Islands, 00°29'S, 89°54'30" W. U.S. Fish Commission Steamer *Albatross*, 15 April 1888; Station 2818; 717 m, white and black sand, large beam trawl; bottom temperature 6.6°C.

*Diagnosis.*—A fairly large stenopodidean shrimp, with a stout, depressed body, generally glabrous; telson with 6-7 lateral teeth and 8 smaller teeth on posterior margin; uropodal exopodite with 13-18 teeth on outer margin, dorsally 1 strong and 1 weak ridge; dactyli of fourth and fifth pereopods triunguiculate; third maxilliped with spines; scaphocerite with 10 teeth.

*Description.*—Holotype (female, USNM 180064). Rostrum (Figs. 1, 2A) short, compressed, extending almost to distal end of antennular peduncle basal segment, tapering gradually into slightly upturned acute tip. Dorsal

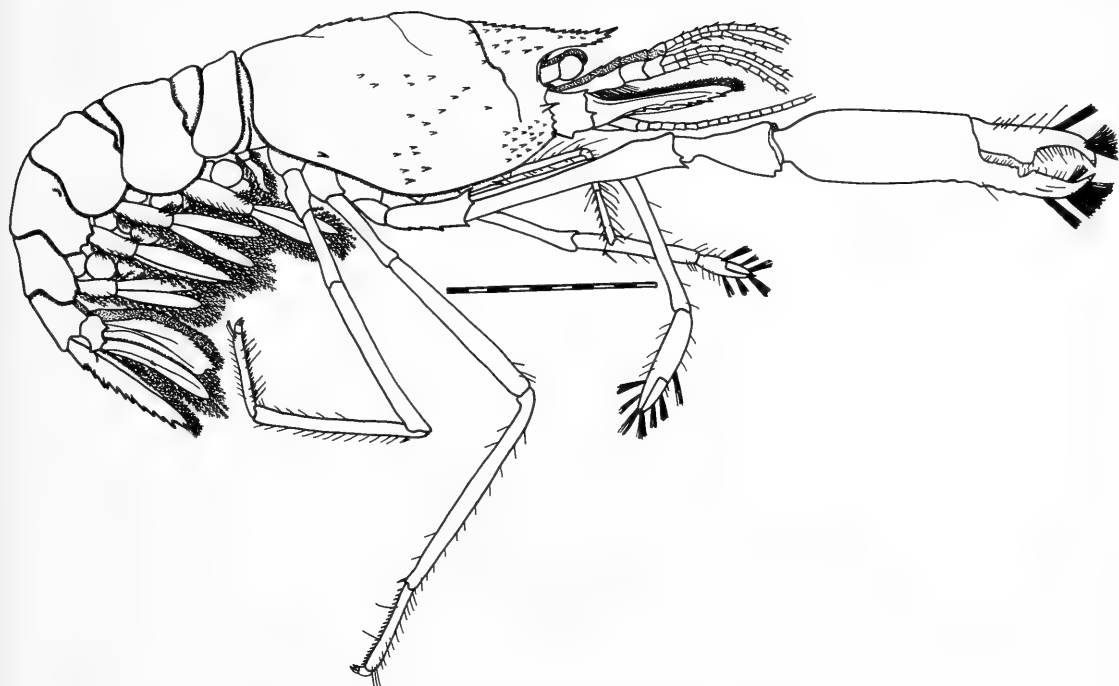


Fig. 1. *Spongicoloides galapagensis*, holotype, female. Scale bar in mm.

margin bearing 7 strong spines; ventral margin bearing 4 strong spines. Rostral base triangular with each lateral margin bearing 3 small spines.

Carapace (Figs. 1, 2A) of very thin texture, with distinct cervical groove; less distinct, shorter postcervical groove. Dorsal midline bearing 5 small spines anterior to cervical groove, 4 slightly larger spines posterior to postcervical groove. Frontal region behind rostrum up to cervical groove bearing 8 small spines. Three small spines present directly behind anterior part of cervical groove, which in dorsal view appear to be on cervical groove itself. Small antennal spine, large branchiostegal spine and 4 small pterygostomial spines with pterygostomial region also bearing numerous minute spinules somewhat arranged in rows. Branchial region having numerous scattered spines; branchiostegite bearing large spine close to posterolateral border. Ventrolateral angle of carapace somewhat rounded while posterolateral angle of branchiostegite obtusely angled, slightly concave.

Abdominal somites glabrous, lacking carinae. Pleura of first 3 rounded, without setae ventrally. Anterolaterally, second and third somites bearing articular knobs, while fourth somite with distinct knob. Pleura of fourth and fifth somites ending in 3 small teeth.

Telson (Fig. 2B) broad, roughly rectangular, slightly constricted at base. Dorsal surface with 2 longitudinal ridges; left ridge having 7 spines and right 8. Anteriorly, 2 spines and another outside proximal part of left ridge. Lat-

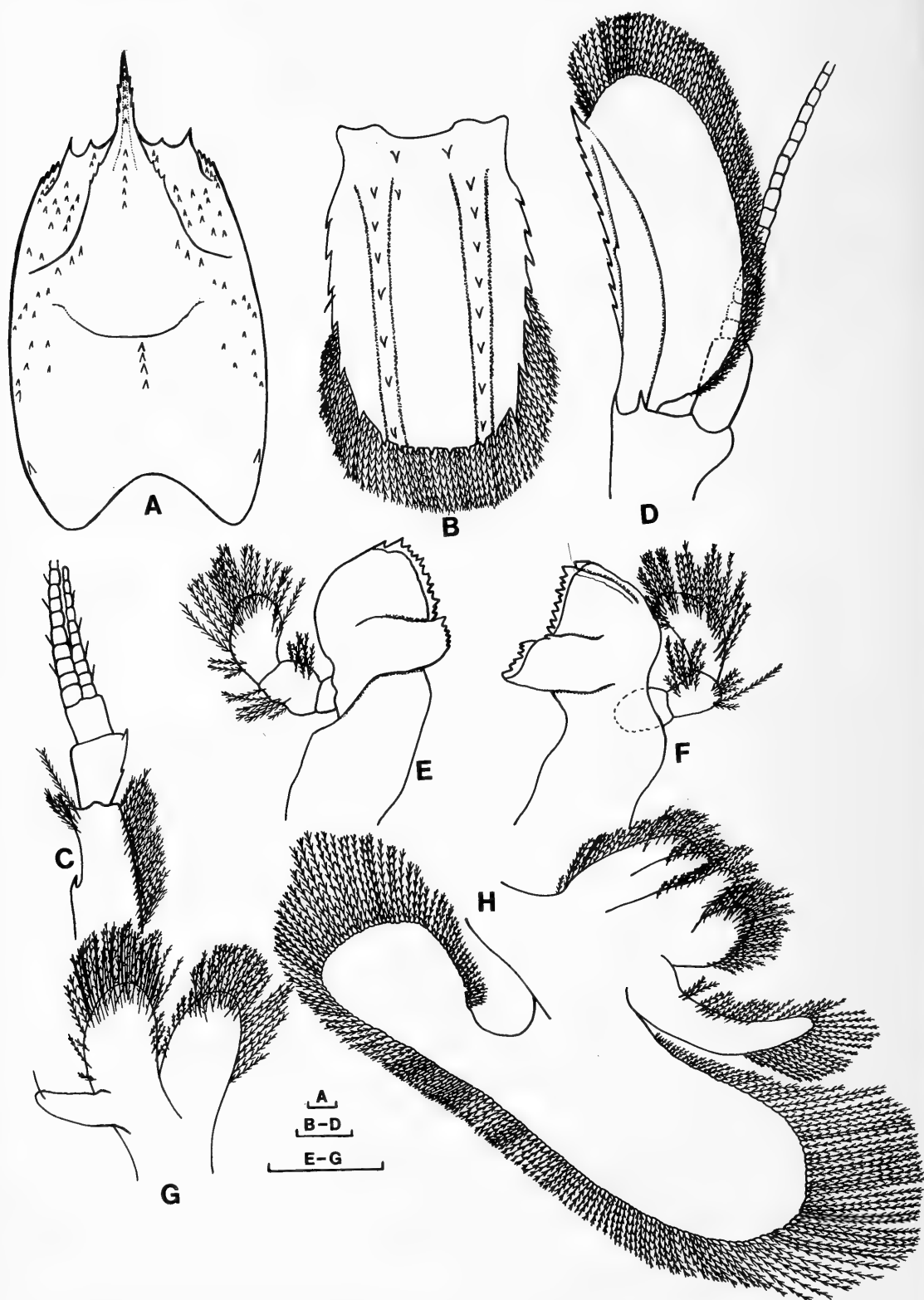


Fig. 2. *Spongiocoloides galapagensis*, holotype, female: **A**, Carapace, dorsal view; **B**, Telson, dorsal view; **C**, Antennule, dorsal view; **D**, Antenna, dorsal view; **E**, Right mandible, ventral view; **F**, Same, dorsal view; **G**, Maxillule; **H**, Maxilla. Scale bars represent 1.0 mm.

eral borders bearing 6 left and 7 right acute teeth; borders setose along distal third. Posterior margin broadly rounded, densely setose, with 8 small teeth.

Eyes well developed, of moderate size, cornea globular and devoid of black pigment. No spinules on ophthalmic peduncle.

Antennular peduncle (Fig. 2C) short, extending to middle of scaphocerite. Basal segment more than twice length of second segment, third much shorter than both. Inner margin of basal segment straight, bearing 18 plumose setae of moderate length. Outer margin slightly expanded proximally bearing minute stylocerite about midlength, while distal extremity comes to sharp point with 4 plumose setae. Second segment with 2 small spines on inner margin; distal segment glabrous. Lateral flagellum slightly stronger than mesial flagellum, both with some segments bearing short setae.

Antenna (Fig. 2D) with stout basicerite, having strong spine on distal margin. Carpocerite short, not exceeding second antennular peduncle segment. Antennal flagellum broken at sixteenth segment. Scaphocerite broad, quadrangular, dorsally bearing 2 faint longitudinal carinae, with one bearing small knob about mid-length; outer margin slightly concave bearing 9 small teeth and larger distal tooth, inner margin convex, fringed with 84 long plumose setae.

Mandible (Figs. 2E, F) robust, with short fused molar and incisor processes. Molar surface with 6 small teeth; incisor bearing 2 stout teeth distally followed by 11 small teeth proximally. Palp well developed, 3-segmented. Proximal segment without setae; middle segment setose mesially, on distal outer margin; distal segment broad, densely setose laterally and distally.

Maxillule (Fig. 2G) bearing simple undivided endopodite with terminal short seta. Distal endite narrow with numerous fine setae and 11 stout spines distally; proximal endite also narrow with many fine setae distally.

Maxilla (Fig. 2H) with following setation on coxal and basal endites: 32 on proximal lobe, 16 on distal lobe of coxal; 20 on proximal lobe, 38 on distal lobe of basal. Endopodite long, slender, with 36 lateral and distal plumose setae. Scaphognathite well developed; anterior lobe broad, posterior one narrow with 208 plumose setae along margin.

First maxilliped (Fig. 3A) with stout 3-segmented endopodite. Proximal segment long, narrow proximally, broader distally, bearing 18 long plumose setae on outer margin, 15 shorter plumose setae mesially, and 4 plumose setae on inner margin. Middle segment broad, less than half length of basal segment, with 18 long plumose setae on outer margin and 2 long plumose setae distally. Distal segment very small, vestigial, with 2 short plumose setae. Basipodite large, rounded anteriorly, with straight mesial border bearing dense fringe of long setae. Coxopodite represented by somewhat rounded lobe bearing 10 short setae. Exopodite well developed bearing 11 long plumose setae laterally and distally. Large epipod present with broad proximal and distal lobes.

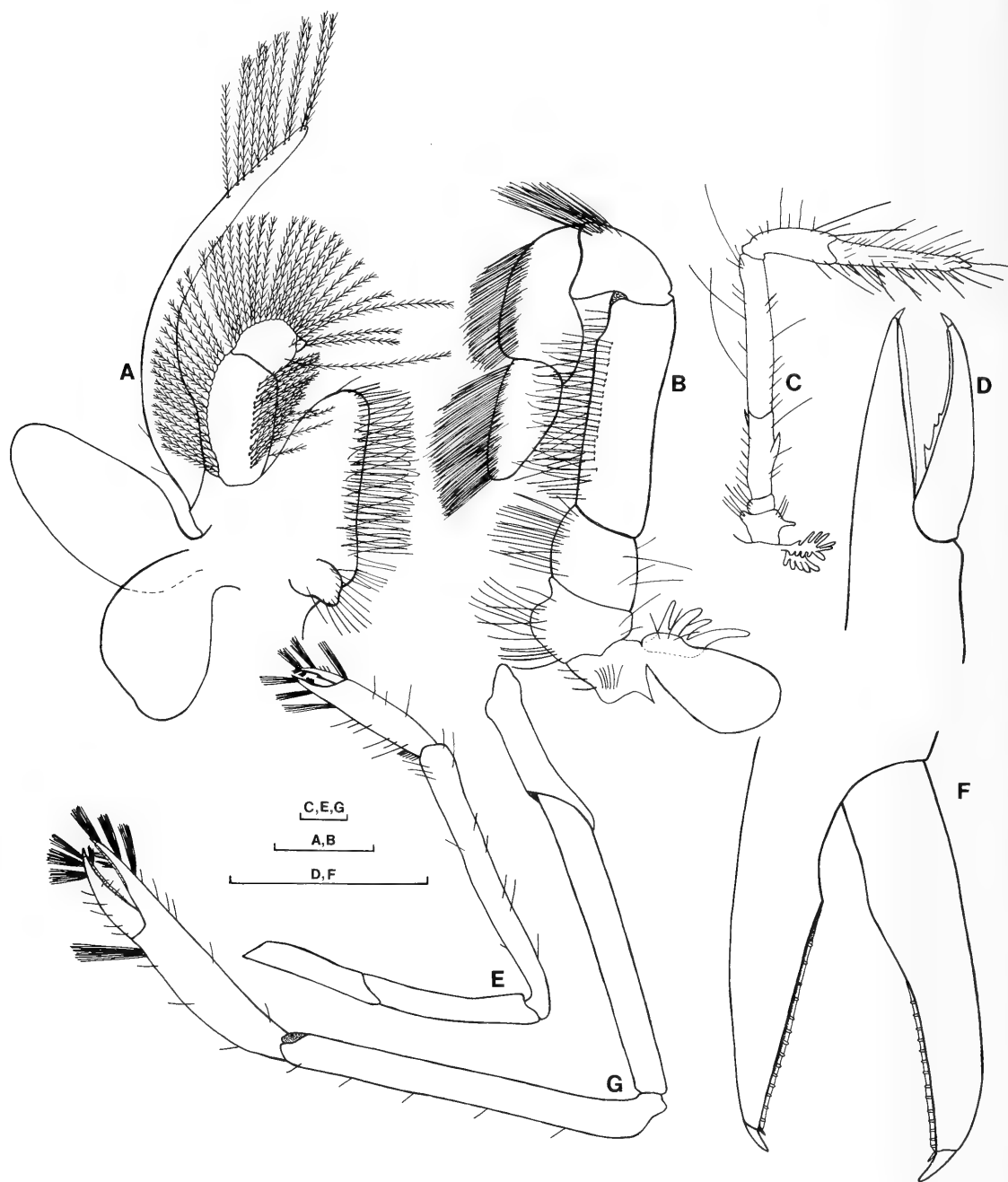


Fig. 3. *Spongicoloides galapagensis*, holotype, female: A, First maxilliped; B, Second maxilliped; C, Third maxilliped, with dactylus missing; D, E, Chela of first pereopod; F, G, Chela of second pereopod. Scale bars represent 1.0 mm.

Second maxilliped (Fig. 3B) with 7-jointed endopodite. Dactylus suboval, about twice as long as broad, with densely setose distodorsal margin. Propodus about 1.2 length of dactylus with dense fringe of setae on distodorsal margin, while carpus short, triangular about half propodal length with numerous long simple setae at distodorsal angle. Merus long, straight, twice propodal length with dense fringe of long setae on inner border. Ischium

and basis not fused, both short with many setae on inner margins, few on outer margins. Coxa with 3 short setae on inner margin, 6 setae mesially, and simple epipod bearing small podobranch laterally. No exopodite present.

Third maxilliped (Fig. 3C) with 7-segmented endopodite, but dactylus missing on specimen. Propodus long, narrow, with 5 spines on inner margin; numerous long and short simple setae mesially, on outer and inner margins. Carpus slightly shorter than propodus with 2 long distal setae on inner border, numerous long and short setae on outer border. Merus longest segment with 3 long, few short setae on outer margin, few setae on inner margin. Ischium as long as carpus with few setae, strong spine on inner margin; small distal spine, some short setae on outer margin. Basis without exopodite but with 3 short setae on outer border. Distal end of coxa produced into rounded point bearing 3 short setae on outer margin; inner margin with 3 short setae, small epipod. Arthrobranch, pleurobranch present.

First pereopod (Figs. 3D, E) small, slender, glabrous; when extended reaching slightly beyond scaphocerite. No setiferous organ present. Dactylus less than half propodal length. Fingers slightly compressed with slightly hooked tips. Cutting edges rather indistinct with propodus and dactylus bearing chitinous ridge along inner margins. Dactylar ridge proximally forms one large, 2 smaller acute teeth. Both tips of propodus and dactylus rounded, heavily chitinized. Fingers and distodorsal extremity of palm with small tufts of long setae. Carpus longest segment, more than twice propodal length, with few simple setae on inner and outer margins. Ischium same size as propodus; merus slightly longer. Basis and coxa short, unarmed.

Second pereopod (Figs. 3F, G) similar to first, but longer, stronger. Fingers and distodorsal extremity of palm bearing small tufts of long setae. Cutting edges provided with 14 small, stout, peg-like teeth separated by rectangular chitinous lamellae; near tips each edge with small, spike-like tooth; tips hooked, heavily chitinized. Carpus longest segment with 5 short simple setae along outer margin. Merus almost equal in length to carpus, ischium one-third carpal length. Basis and coxa short, unarmed.

Third pereopod (Figs. 1, 4A) largest, strongest, almost as long as entire body length. Dactylus with chitinous ridge along cutting edge with large, rounded, serrate tooth almost at midlength opposing deep notch in serrate chitinous ridge of propodal cutting edge. Fingers elongate with sharp, hooked, chitinized, crossing tips, bearing small tufts of long setae. Propodus longest segment, distoventrally bearing 7 small knobs. Carpus less than half propodal length, narrowing proximally. Merus almost same length as propodus, with distoventral angle forming sharp spine with smaller mesial spine directly above. Ischium equal to carpal length, ventrally bearing 4 spines, distodorsal angle produced into large curved spine with smaller mesial spine below. Basis and coxa short, stout, unarmed.

Fourth, fifth pereopods (Figs. 4B, C) long, slender, subequal in length.



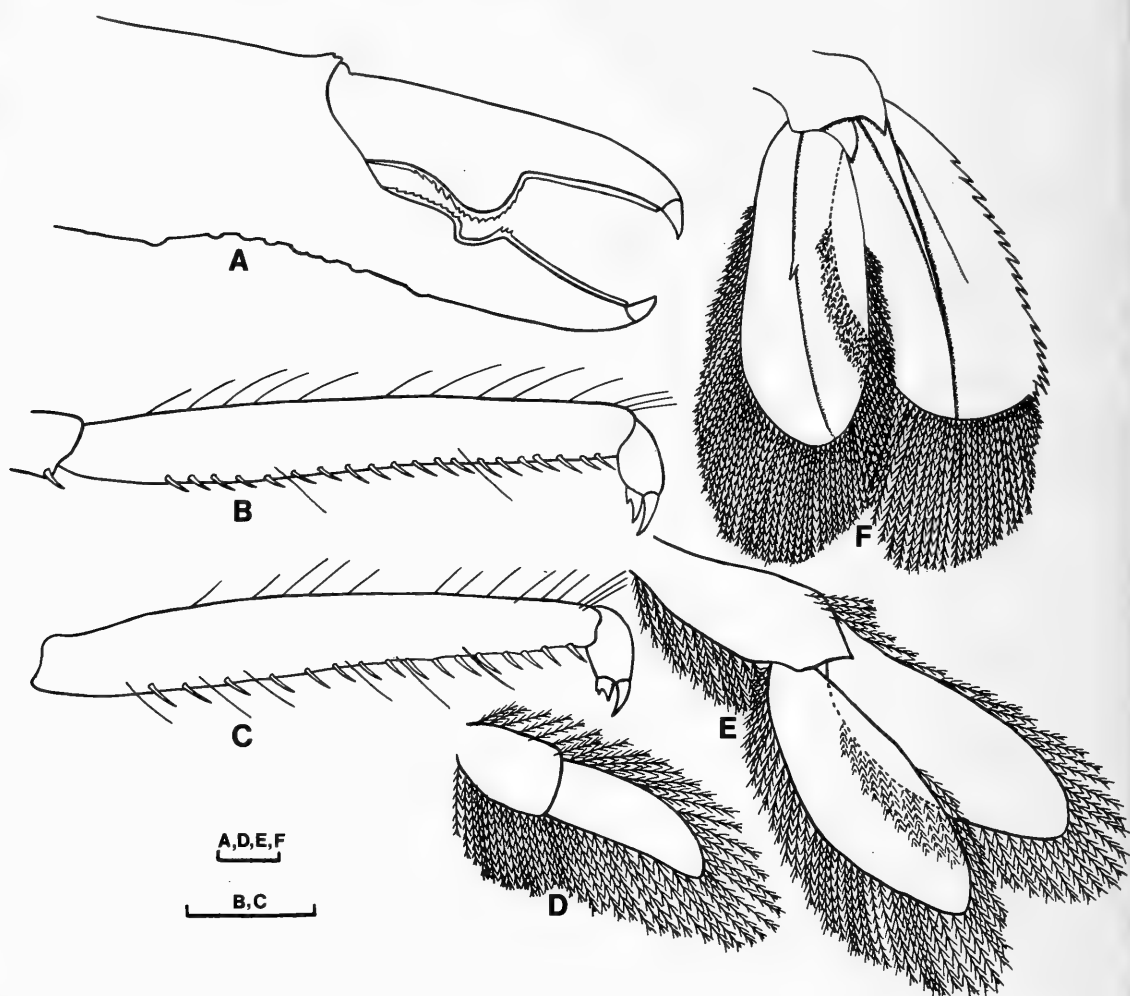


Fig. 4. *Spongiocoloides galapagensis*, holotype, female: A, Chela of third pereiopod; B, Propodus and dactylus of fourth pereiopod; C, Propodus and dactylus of fifth pereiopod; D, First pleopod; E, Second pleopod; F, Right uropod. Scale bars represent 1.0 mm.

Dactylus of fourth triunguiculate with much smaller proximal tooth on accessory spine. Unguis long, curved, clearly separated from dactylar corpus; accessory spine similar but shorter. Propodus and carpus undivided, with propodus about one-third carpal length, bearing 20 movable spines, 2 long setae ventrally; 13 long dorsal setae. Carpus longest segment with 11 dorsal setae, 4 ventral setae, movable spine at distoventral angle. Merus almost same length as carpus with 3 long distal setae dorsally. Ischium same length as propodus; unarmed. Basis and coxa short, stout. Fifth pereiopod with similar dactylus as fourth but much smaller unguis and accessory spine. Propodus half carpal length bearing 16 movable spines, 6 long setae ventrally; 13 long dorsal setae. Carpus and merus equal length; merus unarmed and carpus bearing 14 dorsal setae, 7 ventral setae. Ischium same length as propodus; unarmed. Basis and coxa short, stout.

First pleopod (Fig. 4D) uniramous, second (Fig. 4E) to fifth biramous, all lacking appendices. First pleopod smallest, with exopodite slightly longer than basipodite. Dorsal, ventral margins of basipodite densely covered with long plumose setae. Exopodite with 28 long plumose marginal setae. Rami of second pleopod slightly longer than basipodite. Distodorsal margin of basipodite bearing 5 short plumose setae, ventral margin with numerous longer plumose setae. Exopodite, endopodite respectively bearing 36, 42 long plumose marginal setae. Third to fifth pleopods generally similar, decreasing in size, setation posteriorly.

Uropods (Fig. 4F) well developed, about as long as telson. Basal segment strong with distodorsal angle produced into large tooth, large mesial tooth. Exopodite, endopodite ovate with outer margin of left exopodite bearing 13 teeth, right exopodite bearing 18 teeth. Unarmed margin of exopodite with 78 long plumose setae, dorsal surface bearing strong median ridge, much weaker submedian ridge. Margins of endopodite unarmed, bearing 102 long plumose setae. Dorsal surface with median ridge with spine located about mid-length.

There are only 20 large eggs, about 2.0 mm long and 1.3 mm broad.  
Branchial formula:

	Maxillipeds			Pereiopods				
	I	II	III	I	II	III	IV	V
Pleurobranchs	—	—	1	1	1	1	1	1
Arthrobranchs	—	—	1	1	1	1	1	—
Podobranchs	—	1	—	—	—	—	—	—
Epipods	1	1	1	—	—	—	—	—
Exopods	1	—	—	—	—	—	—	—

Measurements (in mm): Postorbital carapace length, 14.0. Rostral carapace length, 17.0. Total length, approx., 39.0. Length of third pereiopod, approx., 36.5.

Coloration: The color of the preserved specimen is a pale yellow, the color of the living animal is unknown.

Type-locality.—Eastern Pacific Ocean, off the Galapagos Islands.

Remarks.—The new species, *Spongicoloides galapagensis*, follows the definition of the genus *Spongicoloides* Hansen given by Holthuis (1946), only differing in the spinous third maxillipeds, having 2 dorsal ridges on the uropodal exopodite, and the triunguiculate dactyli of the last 2 pairs of legs. Holthuis used the branchial formulae as one of the means of distinguishing the 4 known species of *Spongicoloides*. In this regard, *S. galapagensis* comes close to *S. inermis*, but the podobranch on the second maxilliped and the arthrobranch on the fourth pereiopod are not rudimentary in the new species. *Spongicoloides inermis* also bears 4 small knobs on the ventral

Table 1.—Comparison of some morphological characters in the genus *Spongicoloides*.

	<i>S. galapagensis</i>	<i>S. profundus</i>	<i>S. koehleri</i>	<i>S. inermis</i>	<i>S. evolutus</i>
Teeth on rostrum	7D, 4V, 3L	5-7D, 0-3V, 0L	6-9D, 0-4V, 0L	4D, 0V, 0L	some D, some V
Teeth on outer margin of scaphocerite	10	4-7	2-5	3-6	?
Carapace spination	numerous	numerous	few	glabrous	?
Arthrobranchs on 3rd Mxp, 1st-4th legs	1	1	2	1	2
Epipods or cicatrices visible on 1st-4th legs	absent	absent	present	absent	present
Teeth on longitudinal telson ridges	7-8	9-10	?	3-4	?
Lateral telson teeth	6-7	6-7	4-14	5	?
Teeth on outer margin of uropodal exopodite	13-18	16	?	7	?
Dactyli of 4th & 5th legs	triunguiculate	biunguiculate	biunguiculate	biunguiculate	?
Spination of 3rd leg	merus & ischium	glabrous	merus & dactylus	merus	?
Propodal knobs on 3rd leg	present	absent	absent	present	?
Spines on 3rd maxilliped	present	absent	absent	absent	absent
Eye cornea	white (pigmented), as broad as peduncle	white (pigmented), as broad as peduncle	annular band of black pigment, as broad as peduncle	unpigmented, narrower than peduncle	?
Vertical distribution	717 m	1,480 m	760-1,410 m	780 m	882 m

(abbreviations: Mxp = maxilliped; D = dorsal; V = ventral; and L = lateral).

margin of the third pereopod propodus, similar to the 7 knobs on *S. galapagensis*. The new species has a few characters similar to the genus *Spongiocaris* Bruce and Baba, namely the dactyli of the fourth and fifth pereopods and the dorsal ridges on the uropodal exopodite. This supports Bruce's and Baba's (1973) statement that the genus *Spongiocaris* seems to be an intermediate form between *Spongicola* and *Spongicoloides*. In most other respects, the new species is most closely related to *Spongicoloides profundus*, but it is easily distinguished from members of the genera *Spongiocaris* and *Spongicoloides* by differences of the telson, spination of the carapace, and branchial formula. The new species differs from the other members of the genus *Spongicoloides* in a number of other characters shown in Table 1.

The 4 previously described species of *Spongicoloides* are known only from the Atlantic Ocean. There is not much known of the characteristics of *S. evolutus* (Bouvier, 1905), based on a single specimen collected off the west coast of the Sahara. The only characteristics given by Bouvier (1905a, 1908a) and Milne Edwards and Bouvier (1909) are shown in Table 1. *Spongicoloides profundus* Hansen, 1908 has only been recorded southwest of Iceland, 60°37'N, 27°52'W (Hansen, 1908); *S. inermis* (Bouvier, 1905) was collected off St. Lucia in the Caribbean (Bouvier, 1905b, 1908b; Milne Edwards and Bouvier, 1909); and *S. koehleri* (Caullery, 1896) has been collected from the Bay of Biscay and the Atlantic Ocean near the Strait of Gibraltar (Caullery, 1896; Kemp, 1910; Sund, 1920). The new species is the first record of the genus from the Pacific Ocean. Three specimens of yet another Western Atlantic species of *Spongicoloides* were found in the unidentified stenopodid material of the U.S. National Museum. This species differs from *S. galapagensis* and the other members of the genus by differences in the rostrum, scaphocerite, telson, and uropods and a full description will be presented in a forthcoming publication.

### Acknowledgments

I am extremely grateful to Dr. Raymond B. Manning, Curator, Department of Invertebrate Zoology, Smithsonian Institution, who gave me the opportunity to describe this new species and reviewed the manuscript. I would also like to thank Drs. Fenner A. Chace, Jr. and Brian Kensley, also of the Smithsonian Institution, for critically reviewing the manuscript.

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### ADDENDUM

After this manuscript was sent to the printer the following paper was published: Baba, K. 1979. A new stenopodidean shrimp (Decapoda, Natantia) from the Chatham Rise, New Zealand. Pacific Sci. 33(3):311–314. He describes *Spongiocoloides novaezelandiae* sp. nov., which differs from *S. galapagensis* and the other members of the genus in number of gills and spination of the rostrum.

## A NEW SPECIES OF ROCK SHRIMP OF THE GENUS *SICYONIA* (PENAEOIDEA), WITH A KEY TO THE WESTERN ATLANTIC SPECIES

Isabel Pérez Farfante

*Abstract.*—*Sicyonia olgae*, new species, ranges from Dry Tortugas Is., Florida, to Suriname. It differs from *Sicyonia typica* (Boeck, 1864), its closest western Atlantic relatives, in possessing sublateral carinae on the carapace, and in lacking posterior pleural sulci on the first three abdominal somites; also, distinctive are the sharply pointed, mesially directed, distomesial projection of the petasma in the male, and in the female the pair of long, slender spines on sternite XI and rounded posterolateral processes of the median plate of sternite XIII. A key to the western Atlantic species of *Sicyonia* is supplemented by synopses of their geographic and depth ranges which include many extensions of previously known limits.

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The shrimp genus *Sicyonia* was previously known to be represented by eight species in the western Atlantic, but an examination of the collections of these shrimps in the National Museum of Natural History, Smithsonian Institution (USNM), brought to light a ninth species here described as new.

Some of those *Sicyonia* are present in relatively large quantities in commercial catches of shrimps of the genus *Penaeus*, and one, *S. brevirostris* Stimpson, 1871, is large and abundant enough to sustain a fishery which rendered about 3,700,000 lbs (heads-off weight) in 1979.<sup>1</sup> Although the collections examined are rather extensive, the number of available specimens of the new species is limited; thus additional material may demonstrate variations in some of the characters treated.

*Sicyonia olgae* has the broadest bathymetric range—from 33 to 622 m—of any of its western Atlantic congeners. The species of *Sicyonia* typically occur in shallow water, but the range of many of them, like that of the new species, extends across the continental shelf onto the slope, to depths of a few hundred meters. Such pattern of bathymetric distribution is not uncommon among penaeoidean shrimps; for example, certain species of *Metapenaeopsis* have been recorded from less than 20 to more than 300 m, and *Parapenaeus longirostris* (Lucas, 1846), a species commercially exploited

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<sup>1</sup> Data provided by Roger W. Hutchinson, Natl. Mar. Fish. Serv., Fish. Develp. Div., U.S. Dept. of Commer., NOAA.

in the Mediterranean and eastern Atlantic, ranges from less than 20 m to at least 700.

Because two new species of the genus *Sicyonia* have been discovered since the appearance of the most recent key to the western Atlantic species of the genus (Chace, 1972<sup>2</sup>), a modified version of it is presented below. A study of extensive collections of *Sicyonia* from that region shows that the geographic and depth ranges of many species are considerably greater than was previously realized. Synopses of geographic and bathymetric ranges are included after the key.

The occurrence of *S. brevirostris* in the eastern Pacific is cited under "Geographic and bathymetric ranges. . . ." with hesitation. The only record of its presence outside the western Atlantic is that of Burkenroad (1934) who reported a single juvenile specimen from off the Pacific coast of southern Mexico (off Tapachula, Chiapas). I have examined this specimen, and agree with his determination. However, because *S. brevirostris* has not been reported again from the region, nor have I found any representatives among the many hundred specimens of *Sicyonia* I have examined from the Pacific coast of America (including large collections from Mexican waters), its occurrence there needs to be confirmed.

The terminology employed in describing the external genitalia, and transverse sulci on the pleonic pleura is that proposed by Kubo (1949) and Burkenroad (1934), respectively, the former slightly modified by Pérez Farfante (1969). The length of the carapace was measured from the orbital margin to the midposterior margin, and the total length, from the apex of the rostrum to the posterior end of the telson. The scales accompanying the illustrations are in millimeters.

Key to the Western Atlantic Species of *Sicyonia*

- 1. Antennal spine absent or occasionally exceedingly weak; second abdominal somite with narrow notch or perpendicular incision in anterior half of dorsal carina; first pereopod with short distal spine on basis and ischium ..... 2
- Antennal spine well developed or clearly distinct; second abdominal somite with dorsal carina entire, not incised; first pereopod with basis and ischium unarmed ..... 3
- 2. Postrostral carina armed with 3 unequal teeth, anterior one smallest; first abdominal somite with 1 well marked vertical (posteromedian)

<sup>2</sup> A later key by Huff and Cobb (1979) is restricted to the Gulf of Mexico and the Atlantic coast of Florida.

- sulcus and sometimes with 1 short, barely distinct more anterior one (anteromedian) on pleuron ..... *S. laevigata* Stimpson, 1871<sup>3</sup>
- Postrostral carina armed with 3 subequal teeth; first abdominal somite with 3 vertical sulci on pleuron, posterior one (posterior pleural) less conspicuous ..... *S. parri* (Burkenroad, 1934)
  - 3. Postrostral carina bearing 2 or 3 large teeth posterior to level of hepatic spine ..... 4
  - Postrostral carina bearing 1 large tooth posterior to level of hepatic spine ..... 6
  - 4. Postrostral carina with 3 large teeth posterior to level of hepatic spine ..... *S. brevirostris* Stimpson, 1871
  - Postrostral carina with 2 large teeth posterior to level of hepatic spine ..... 5
  - 5. Rostrum armed with 1 or 2 teeth (excluding tip) anterior to orbital margin; first abdominal somite with 3 vertical sulci on pleuron ....  
..... *S. typica* (Boeck, 1864)
  - Rostrum armed with 3 or 4 teeth (excluding tip) anterior to orbital margin; first abdominal somite with 2 vertical sulci on pleuron (posterior one lacking) ..... *S. olgae*, n. sp.
  - 6. First abdominal somite with tooth at anterior end of dorsal carina bifurcate; fifth abdominal somite without tooth or sharp angle at posterior end of dorsal carina ..... *S. wheeleri* Gurney, 1943
  - First abdominal somite with tooth at anterior end of dorsal carina not bifurcate; fifth abdominal somite with tooth or sharp angle at posterior end of dorsal carina ..... 7
  - 7. First abdominal somite with anteroventral margin of pleuron concave or straight; fourth abdominal somite with posteroventral margin of pleura angular or with posteriorly oriented spine; fourth and fifth abdominal somites with long acute spine on either side of midline of posterodorsal margin ..... *S. dorsalis* Kingsley, 1878
  - First abdominal somite with anteroventral margin of pleuron slightly or strongly convex; fourth abdominal somite with posteroventral margin of pleura rounded; fourth and fifth abdominal somites with short, obtuse projection on either side of midline of posterodorsal margin ..... 8

<sup>3</sup> The number of rostral teeth which has been widely used to distinguish *S. laevigata* from *S. parri* is omitted here because both possess 3, contrary to previous statements that *S. laevigata* bears only 2. In the young and many adults of the latter the third tooth is placed so far anteriorly that it appears to constitute a part of the tip dentition; the apical dentition consists of 1 to 3 minute teeth in addition to a ventral one that usually becomes situated farther posteriorly with increasing size of the shrimp.



8. First four abdominal somites with anteroventral angle of pleura lacking laterodorsally curved spine (small, ventrally directed obtuse spine occasionally present); last two abdominal somites with well-defined tooth at posterior end of dorsal carina .....  
..... *S. stimpsoni* Bouvier, 1905
- First four abdominal somites with anteroventral angle of pleura bearing laterodorsally curved, acute spine; last three abdominal somites with well-defined tooth at posterior end of dorsal carina. ....  
..... *S. burkenroadi* Cobb, 1971

Geographic and Bathymetric Ranges of Western Atlantic  
Species of *Sicyonia*

*Sicyonia brevirostris* Stimpson, 1871. Off Norfolk, Virginia, through the Bahamas to southern Cuba, around the Gulf of Mexico to southern Texas, and from Bahía de Campeche to northeast Yucatan (it has not been recorded from the east coast of Mexico); a single specimen from off Chiapas (Pacific coast), Mexico. Shallow water to 350 m.

*Sicyonia burkenroadi* Cobb, 1971. Cape Lookout, North Carolina, southward through the Gulf of Mexico and the Caribbean to Ilha Itaparica, Bahia, Brazil. Depth 29 to 585 m.

*Sicyonia dorsalis* Kingsley, 1878. Cape Hatteras, North Carolina, southward through the Gulf of Mexico, and along the Caribbean coast of Central and South America to Enseada de Tijucas, Santa Catarina, Brazil (records from the West Indies are in need of confirmation). Depth 3 to 420 m.

*Sicyonia laevigata* Stimpson, 1871. Cape Hatteras, North Carolina, to Biscayne Bay; along west and northwest Florida; Yucatan; and from the Bahamas, through the Caribbean southward to Anse de Zimbros, Santa Catarina, Brazil; also along the Pacific coast of Panama. Shallow water to at least 100 m.

*Sicyonia olgae*, n. sp. Dry Tortugas Is., Florida, through the Antilles to Suriname. Depth 33 to 622 m.

*Sicyonia parri* (Burkenroad, 1934). Beaufort, North Carolina, through the West Indies and southward to Ponta do Corumbáú, Brazil (it is not known to occur on the continental shelf of the Caribbean). Shallow water to 37 m.

*Sicyonia stimpsoni* Bouvier, 1905. Cape Hatteras, North Carolina, to the Straits of Florida; eastern Gulf of Mexico; and from the Bahamas through the Caribbean to Suriname. Depth 20 to 420 m.

*Sicyonia typica* (Boeck, 1864). Off Wrightsville Beach, North Carolina, southward through the Gulf of Mexico and Caribbean (Antilles, Central America and South America) and along the Atlantic coast of South America to SE of Ilha de Santa Catarina, Santa Catarina, Brazil. [Record from Beau-

fort, North Carolina (Hay and Shore, 1918) actually refers to *S. brevirostris* (Burkenroad, 1934:92)]. Shallow water to 101 m.

*Sicyonia wheeleri* Gurney, 1943. Bermudas and Virgin Is. to Sint Eustatius, Lesser Antilles. Depth 2 to 42 m.

*Sicyonia olgae*, new species

Figures 1–3

*Material*.—Holotype: ♀, USNM 173666, 12 mm carapace length, about 44 mm total length; type-locality: off Paramaribo, Suriname, 06°37'N, 55°36'W, 35 m, 3 September 1958, *Oregon* stn 2277.

Paratypes: 1 ♀, USNM 173667, off Dry Tortugas Is., Florida, 33–37 m, 16 August 1933, J. W. Mills. 2 ♂, USNM 173668, off Punta Las Tunas, Puerto Rico, 18°31'N, 66°47'W, 70 m, 8 October 1959, *Oregon* stn 2668. 1 ♀, USNM 173669, NE Islas Los Testigos, Venezuela, 11°40'N, 62°33'W, 585–622 m, 24 September 1964, *Oregon* stn 5039. 1 ♂ 1 ♀, USNM 103513, NE of Georgetown, Guyana, 07°40'N, 57°34'W, 55–49 m, 31 August 1958, *Oregon* stn 2249.

*Description*.—Body robust (Fig. 1). Rostrum horizontal, surpassing eye, reaching or slightly overreaching distal margin of first antennular article, its length 0.3 to 0.4 that of carapace, armed with 3 or 4 teeth decreasing in size anteriorly, and with tip bifid or trifid. Carapace with closely set fine setae dorsally and patches of setae laterally. High postrostral carina bearing 3 or 4 teeth (if 4, rostrum with 3, total number of rostral plus carapace teeth not exceeding 7); 2 behind hepatic spine, anteriormost located slightly behind orbital margin (if 4 teeth present on carapace, second situated slightly anterior to or at level of hepatic spine); first posthepatic tooth located slightly posterior to midlength of carapace, and posteriormost at about 0.8 carapace length from orbital margin. Adrostral carina, parallel to ventral rostral margin, extending from orbital margin almost to tip of rostrum. Antennal spine small and buttressed; hepatic spine, projecting from swollen hepatic region, straight, directed anteriorly, and longer than antennal. Postocular sulcus short. Hepatic sulcus almost horizontal, relatively deep; branchiocardiac carina horizontal, narrow and rather long, extending from about posterior end of hepatic sulcus to not far from posterior margin of carapace; sublateral carina, sometimes weak, almost parallel to branchiocardiac carina.

Stylocerite with short spine distally, long, about 0.8 distance between proximal end of first antennular article and mesial base of distolateral spine; distolateral spine extending to about midlength of second article; antennular flagella short, mesial one gradually tapering distally, slightly shorter than lateral, length of latter equivalent to that of second and third articles combined.

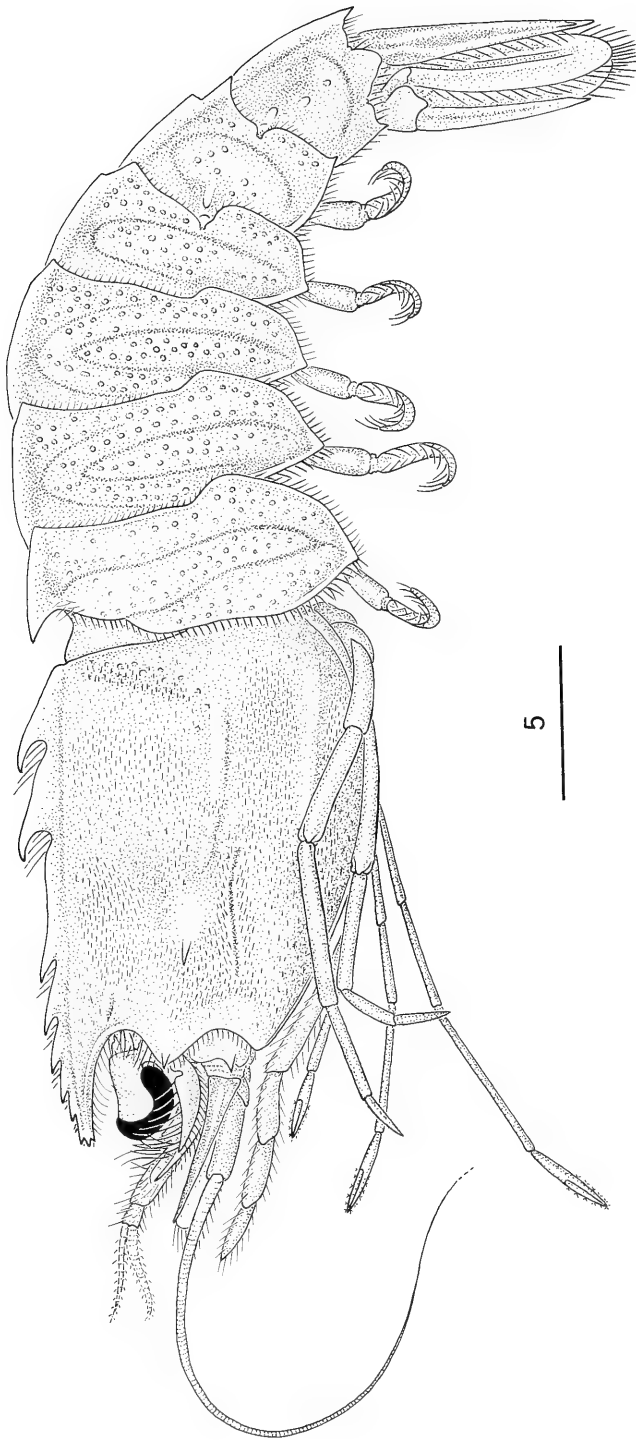


Fig. 1. *Sicyonia olgae*, holotype 12 mm cl, off Paramaribo, Suriname. Lateral view.

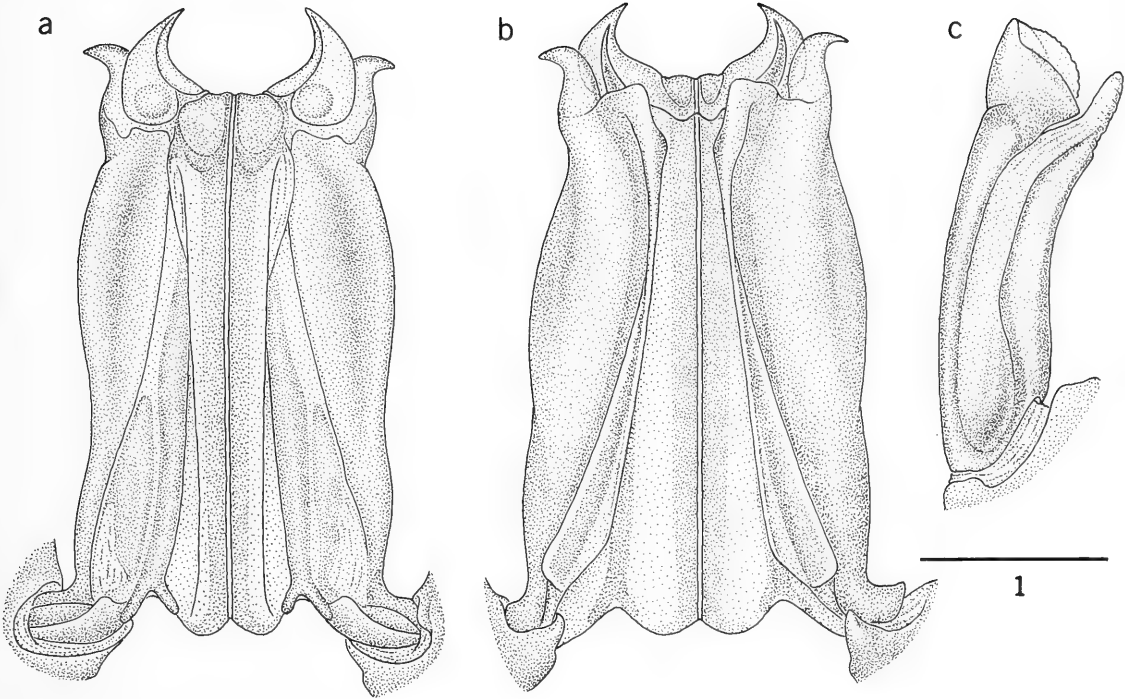


Fig. 2. *Sicyonia olgae*, paratype ♂ 10 mm cl, off Punta Las Tunas, Puerto Rico: a, Petasma, dorsal view; b, Ventral view of same; c, Appendix masculina, dorsolateral view.

Scaphocerite reaching almost to distal end of antennular peduncle; length of antennal flagellum about 2.4 times that of carapace.

Third maxilliped stouter than pereopods, reaching distal end of antennular peduncle or at most exceeding it by dactyl and distal 0.1 of propodus.

First pereopod reaching between proximal and distal ends of middle half of carpocerite. Second pereopod extending to distal end of carpocerite or surpassing it by 0.5 length of dactyl. Third pereopod overreaching antennular peduncle by tip of dactyl or at most by length of propodus, extending only slightly farther than third maxilliped. Fourth pereopod reaching between base and midlength of merocerite. Fifth pereopod extending slightly beyond fourth, at most to basal 0.2 of carpocerite.

Abdomen covered dorsally with fine setae, studded with minute tubercles, densely distributed on anterior 4 somites, bearing dorsomedian carina from first through sixth somites; carina on fifth truncate, ending in abrupt angle, and that on sixth in conspicuous tooth. First somite with anteromedian pleural sulcus (beginning at notch on anterior margin of tergum) joining coalescent posterior tergal and posteromedian sulci ventrally, lacking posterior pleural sulcus. Second and third somites bearing anteromedian and posteromedian pleural sulci and anterior and posterior tergal sulci, lacking posterior pleural sulcus. Fourth and fifth somites with posterior tergal and posteromedian pleural sulci coalescent and continuous with anterior tergal

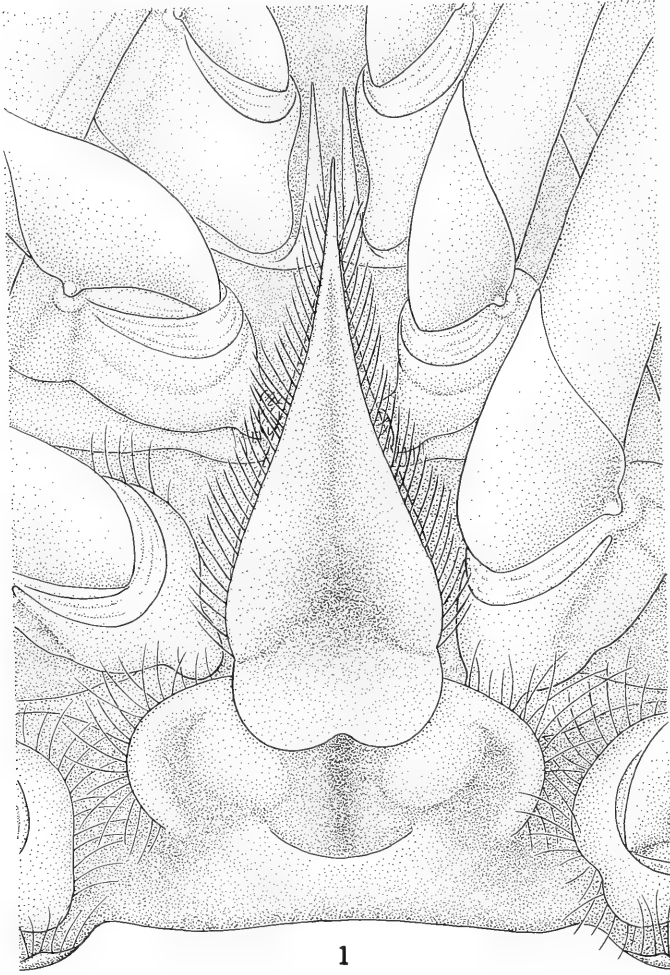


Fig. 3. *Sicyonia olgae*, holotype. Thelycum, ventral view.

sulcus. Sixth somite bearing deep, strongly arched posterior pleural sulcus. Pleura of first 4 somites with anteroventral extremity angular, somites ending in acute tip; fifth and sixth somites rounded anteroventrally. Posteroventral margin of first 3 somites rounded, that of fourth broadly obtuse, and that of fifth and sixth bearing posteriorly directed spine. Telson with short, triangular terminal portion flanked by minute pair of fixed subterminal spines.

Petasma (Fig. 2a–b) with distal part of dorsomedian lobule bearing small, inwardly curved, convex plate. Dorsolateral lobule produced distally in cornified, tear shaped, acutely pointed projection, bearing proximodorsal subhemispherical prominence, and longitudinal ventral groove; dorsolateral lobule forming inconspicuous, rounded proximal process. Ventrolateral lobule heavily cornified, produced distally in fleshy, tapering, laterally directed short projection, with tip sometimes curved proximally; latter projection

situated contiguous to and falling distinctly short of cornified projection of dorsolateral lobule.

Appendix masculina (Fig. 2c), projecting from free distal part of low ridge on dorsomedian margin of endopod, small, roughly campanulate, with ventral wall produced distally beyond dorsal one.

Thelycum (Fig. 3) with plate of sternite XIV forming sharp, rounded lateral flanges and bearing obliquely disposed, oblong bulges separated by broad median depression; latter extending to posterior thoracic ridge. Median plate of sternite XIII triangular in outline anteriorly, tapering into long slender spine reaching about midlength of coxae of second pereopods; plate constricted and deeply excavate at level of coxal plates of fourth pereopods, then continuing posteriorly into short component with rounded posterolateral margins (hiding apertures of seminal receptacles) separated by shallow angular to broadly obtuse median emargination. Posterior thoracic ridge with anteromedian margin concave, and fused laterally with plates of sternite XIV. Paired long, slender spines projecting anteriorly from posterior margin of sternite XI, flanking and extending as far as or beyond spine of median plate of sternite XIII, reaching at least midlength of coxae of second pair of pereopods.

Sizes: males 9–10 mm carapace length, about 36–38 mm total length; females 11–14 mm carapace length, 40–44 total length.

*Geographic and bathymetric ranges.*—This species has been found in waters off Dry Tortugas Is., Florida, through the Antilles southward to Suriname at depths between about 33 and 622 m. Three of the four available samples were obtained at depths of no more than 70 m. Substrates at each of the four localities were different, consisting of mud, shell, coral, or “specks” respectively.

*Affinities:* *Sicyonia olgae* is closely allied to the western Atlantic *S. typica* (Boeck, 1864). The two possess a highly vaulted carapace and an elevated postrostral carina armed with 2 teeth posterior to the level of the hepatic spine.

*Sicyonia olgae* is distinguished from *S. typica* by the following: the armature of the rostrum, consisting of 3 or 4 teeth (not counting tip) instead of only 1 or 2; the presence of a well defined sublateral carina which is lacking or occasionally barely distinct in *S. typica*; the absence of posterior pleural sulci on the first 3 abdominal somites that are always clearly distinct in *S. typica*; the shorter stylocerite, which extends about 0.8 of the distance between the proximal end of the first article of the antennular peduncle and the mesial base of the distolateral spine, but in *S. typica* extends 0.9 the distance, or almost reaches the base of the spine. In females of *S. olgae*, sternite XI is armed with a pair of long, slender spines, that reach at least midlength of the coxae of the second pair of pereopods, and the posterolateral corners of the median plate of sternite XIII are rounded and separated

by a shallow angular or rounded emargination. In contrast, in *S. typica* the spines are small and the posterolateral corners of the median plate of sternite XIII are subrectangular and separated by a deep subrectangular emargination. Also in males of *S. olgae* the dorsolateral lobule of the petasma is produced distally in a sharp, mesially directed projection, whereas in *S. typica* this projection is blunt and twisted—turning mesially and then dorsally.

**Etymology:** This species is named in honor of my sister Dr. Olga Lanio, who through the years followed with utmost interest my shrimp studies.

### Acknowledgments

Horton H. Hobbs, Jr., and Fenner A. Chace, Jr., my colleagues at the Smithsonian Institution, read the manuscript. I am indebted to them for improvements resulting from their suggestions. María M. Diéguez prepared the illustrations.

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## *STENOPUS PYRSONOTUS*, A NEW SPECIES OF STENOPODIDEAN SHRIMP FROM THE INDO-WEST PACIFIC REGION (CRUSTACEA: DECAPODA)

Joseph W. Goy and Dennis M. Devaney

*Abstract.*—A new species of shrimp in the genus *Stenopus* from the Indo-West Pacific region is described and figured. Specimens have been collected from the Hawaiian Islands and Mauritius. The new species, *Stenopus pyrsonotus*, is closely related to *S. hispidus* but is easily distinguished by morphological differences in the rostrum, telson, and spinulation of the body as well as by coloration. A key to the 4 described species from the Indo-West Pacific is included.

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Three of the 5 previously reported species of *Stenopus* are found in the Indo-West Pacific region. *Stenopus hispidus* has a circumtropical distribution (Holthuis, 1946), *S. tenuirostris* is known from the Indian Ocean and Malay Archipelago (Bruce, 1976), and *S. zanzibaricus* was recently described from off the coast of Zanzibar (Bruce, 1976). Collections over several years at Mauritius and in the Hawaiian Islands have provided some interesting specimens of a *Stenopus* that show a striking color pattern differing markedly from the other three Indo-West Pacific species. Besides this distinctive coloration, morphological characters distinguish the specimens from the other species in the genus. They are described here as representing a new species. Specimens recorded herein are deposited in the Bernice P. Bishop Museum (BPBM), Honolulu and the National Museum of Natural History (USNM), Washington, D.C. All material recorded below is considered in the type-series.

*Stenopus pyrsonotus*, sp. nov.

Figs. 1-6

*Material examined.*—HAWAIIAN ISLANDS: OAHU, off Pokai Bay, depth 22.9 m, 13 July 1975, G. Fukuda coll., USNM 173917 (Holotype), USNM 173918 (Allotype), USNM 173919 (Paratype); off Pokai Bay, depth 24.4 m, 29 July 1969, J. E. Randall, S. Swerdloff and D. Chave coll., BPBM S8577, 1 specimen; off Lahilahi Point, in cave, depth 27.4 m, 11 July 1970, J. E. Randall coll., BPBM S8287, 1 specimen; ¼ mile east of Manana Islet (Rabbit Island), from bilge tank of sunken boat, depth 68 m, 14 Oct. 1970, coll. W. D. Madden *et al.*, BPBM S7887, 3 specimens; south of Pokai Bay, depth 22.9 m, under ledge along reef outcrop, 14 Dec. 1972, D. M. Devaney



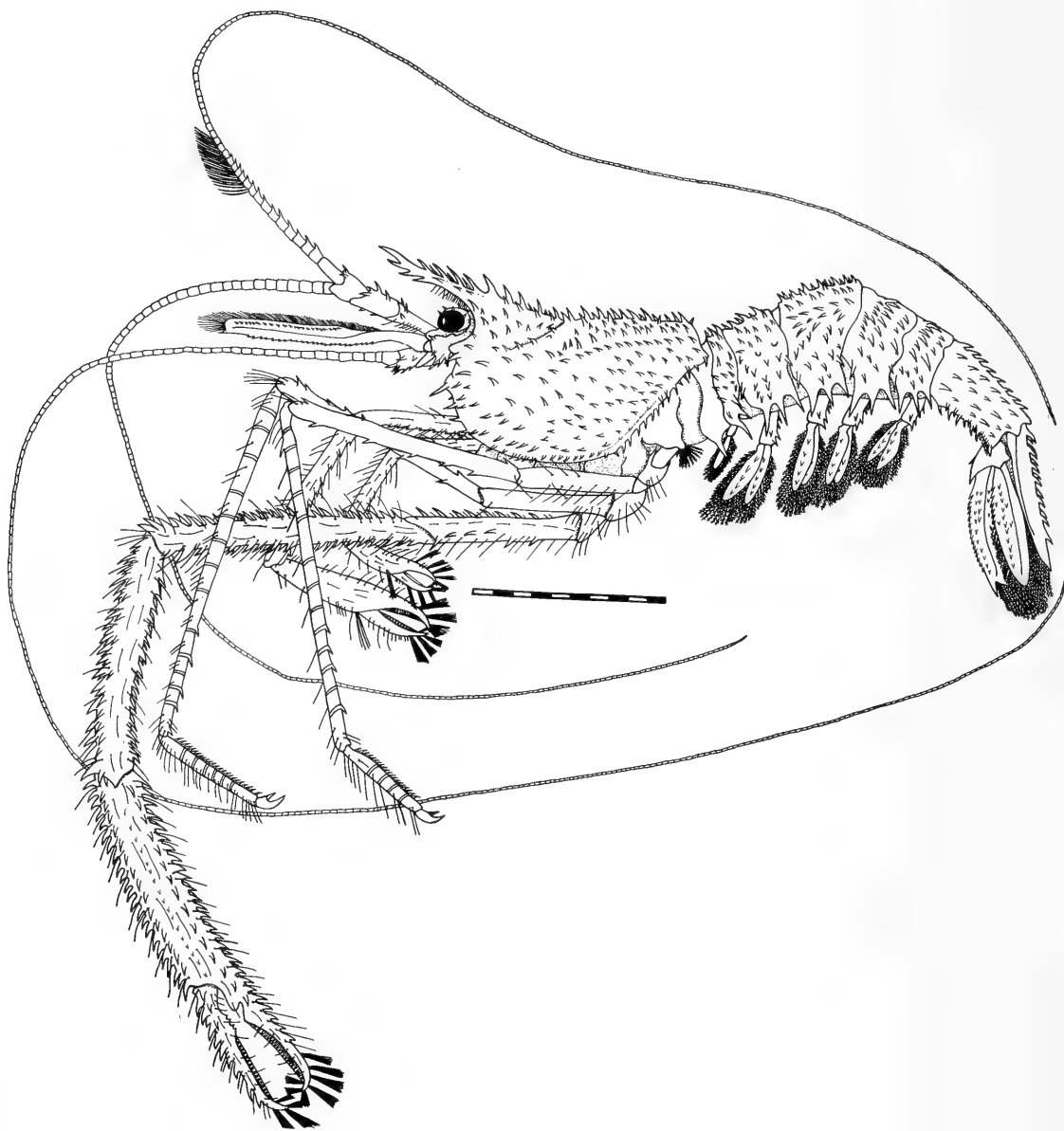


Fig. 1. *Stenopus pyrrsonotus*, holotype, male. Scale in mm.

coll., BPBM S8578, 1 specimen; off Makua, in cave, depth 36.6 m, 19 Aug. 1973, P. Lobel coll., BPBM S8491, S8492, S8493, 3 specimens; Sharks Cove, north shore, in small crevice in side of lava opening, depth 21.3 m, 22 Aug. 1976, G. M. Ludwig coll., BPBM S8579, 1 specimen. HAWAII, Pada Bay, South Kona, 19°14'N lat., 155°55'W long., depth 32 m, 27 June 1976, G. M. Ludwig coll., BPBM S8580.

MAURITIUS: West coast of La Fouce, Medine, in cave, depth 30 m, 19 Nov. 1973, D. Pelicier, J. E. Randall coll., BPBM S8494, 1 specimen; West coast, Cathedral Reef, off Flic en Flac, in cave, depth 30.5 m, 20 Nov. 1973, J. E. Randall, D. Pelicier coll., BPBM S8495, 1 specimen.

*Diagnosis.*—A moderately large stenopodidean shrimp, with slender, compressed body, generally covered with spinous processes; telson lacking marginal spine; scaphocerite with distal marginal tooth separated from others; with red mid-dorsal abdominal stripe.

*Description.*—Holotype (male, USNM 173917). Rostrum (Figs. 1, 2A) long, extending past middle of last antennular peduncle segment, directed slightly upwards, gradually tapering to apex. Dorsal margin with 5 strong spines, distal largest, reaching beyond tip. Ventral margin slightly concave proximally with 3 spines distally, numerous proximal setae. Lateral margins with 3 right spines, 4 left spines, carinae poorly developed.

Carapace (Fig. 2A) densely covered with spinules placed in more or less distinct longitudinal rows. Spinules most strongly developed anterodorsally, smallest over lower and posterior branchiostegite, directed anteriorly. Cervical groove distinct with 5 spines along upper margin. Orbit with small but distinct supraorbital spine. Inferior orbital angle bearing large tubercle and large spine. Large antennal spine present, small hepatic spine at lower end of cervical groove. Ventrolateral angle somewhat rounded, only slightly produced anteriorly while posterolateral angle of branchiostegite obtusely angled and slightly concave.

First 3 abdominal somites with similar forwardly directed spinules similar to those on carapace. First somite with 2 irregular transverse rows of spinules, pleuron ending in 1 weak and 2 strong spines. Second somite with 3 transverse rows of spinules. Pleura of second to fifth somite truncate, each ventrolateral margin with 3 strong spines. Third somite (Fig. 2B) broadly produced with no bare shield-shaped area present. Distolaterally directed spinules of fourth somite arranged in 3 somewhat parallel rows, depressed and squamose; those of fifth somite similar but in somewhat less distinct rows. Sixth somite bearing 2 longitudinal rows of 6 large spinules in mesial region, a medial row of 8 smaller spinules, scattered proximal transverse spinules, and additional lateral spines. Each abdominal somite bearing strong ventral median spine. Ventral surface of sixth somite also densely covered with spinules. Length of fifth abdominal somite 0.4 times that of sixth somite which is about 1.5 times longer than its greatest breadth.

Eyes (Fig. 2C) well developed, with peduncle slightly longer than cornea. Ophthalmic peduncle dorsally with 4 small spinules, 3 extending over cornea; proximodorsal side with 4 small spinules, one extending over cornea.

Telson (Fig. 2D) lance-shaped, with median groove flanked by 2 distinct longitudinal carinae. Telson length approximately 1.6 times that of sixth abdominal somite, 2.5 times longer than anterior width of telson. Carinae provided with 8 left, 6 right strong, posteriorly directed spines, some having 1 or 2 long plumose setae at outer basal side. Strong anterior spine present laterally at telson base, with 5 pairs of median spines occurring between each carina and median groove and extending slightly less than half way

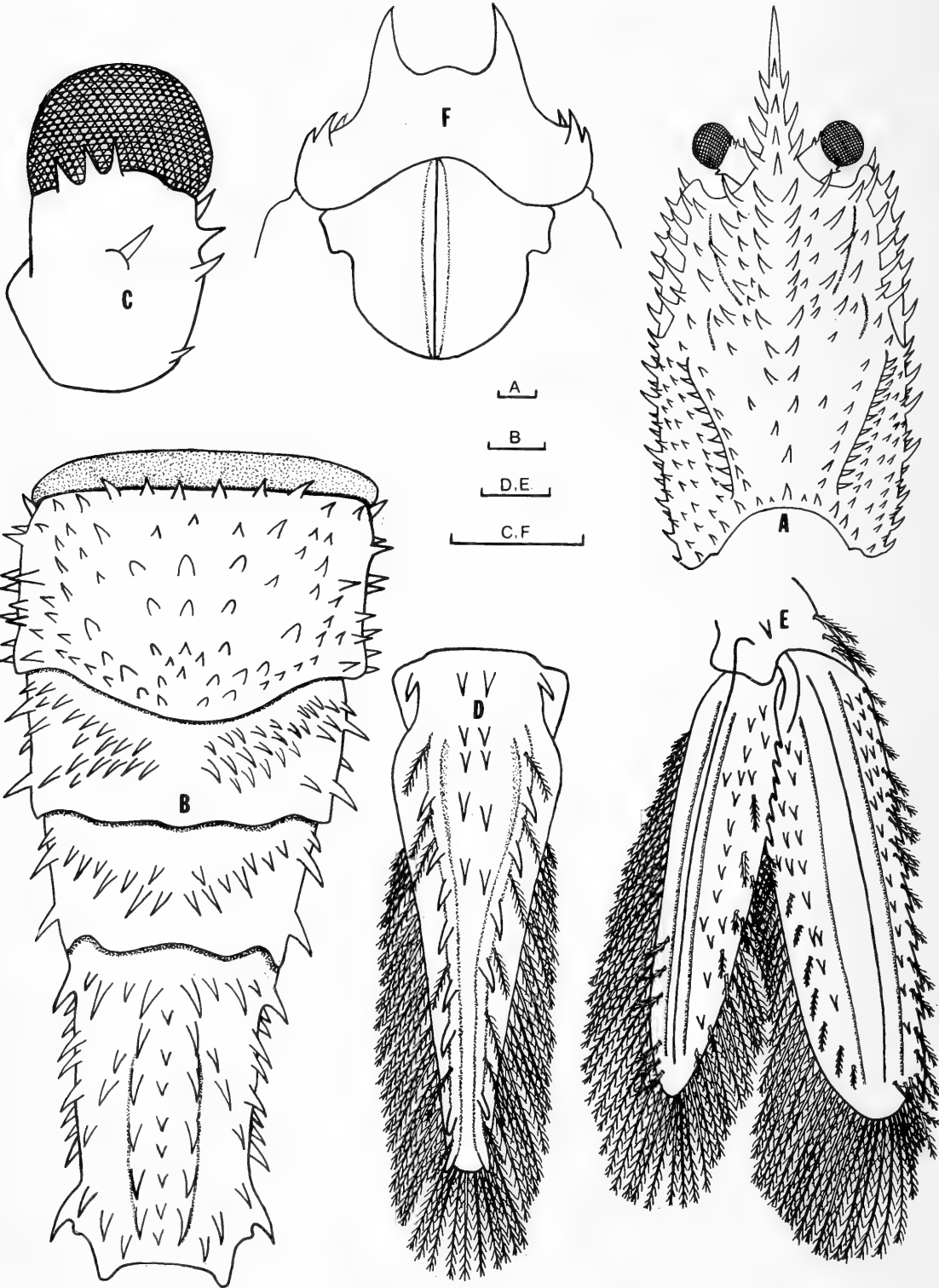


Fig. 2. *Stenopus pyrrsonotus*, holotype, male: A, Carapace, dorsal view; B, Third to sixth abdominal somites, dorsal view; C, Left eye, dorsal view; D, Telson; E, Uropods; F, Epistome and labrum, ventral view. Scale bars represent 1.0 mm.

down telson length. Lateral margin lacking spine, provided with 48 long plumose setae along posterior two thirds. Posterior margin rounded, with last 2 longitudinal carinal spines overlapping margin.

Uropods (Fig. 2E) well developed with endopodite exceeding telson tip but narrower and shorter than exopodite. Basal segment stout with single mesial spine, three outer marginal plumose setae. Exopodite bearing nine acute teeth and 16 short plumose setae on outer margin. Dorsal surface bearing distinct median ridge with 2 longitudinal rows of 6, 13 spines outside; 2 longitudinal rows of 4, 9 spines and 7 short plumose setae inside. Outer proximal margin of endopodite bearing 6 teeth, 5 distal short plumose setae. Dorsal surface bearing distinct median ridge with scattered spines, denser proximally, 4 short plumose setae outside; distal row of 6 short plumose setae inside. Unarmed margins of exopodite, endopodite provided with 36, 52 long plumose setae respectively.

Epistome (Fig. 2F) triangular anteriorly with 2 stout submedian spines next to small median rounded area. Three pairs of spines laterally; labrum normally developed. Paragnath (Fig. 3A) bilobed with lobes separated by median fissure terminating in 2 rounded humps. Thoracic sternites narrow with 2 submedian spinules on segments 4–6, 8 submedian spinules on segments 7–8.

Antennular peduncle (Figs. 3B, C) short, extending to middle of scaphocerite. Basal, middle segments about same length, distal segment considerably shorter. Basal segment about twice as long as wide with broad rectangular process on inner dorsobasal margin; small elongate stylocerite on outer margin, tapering to sharp point; inner distodorsal angle produced into prolonged ridge with 3 strong spines, dorsomedially 2 strong spines, 2 small spines and few setae on outer distodorsal angle. Middle segment with 5 spines on ventral margin, 1 distodorsally, 1 spine on inner proximal margin, also 3 large spines extending out dorsally. Distal segment about 0.6 times length of basal segment with 1 spine distodorsally followed by 2 setae at inner distal margin, smaller medial spine ventrally. Upper flagellum well developed with proximal part bearing 29 groups of aesthetascs beginning on tenth article ending on eighteenth. From article 2 to 15, 16 dorsal spines. Lower flagellum not as strongly developed as upper one.

Antenna (Fig. 3D) with strong basal segment bearing 4 large spines. Scaphocerite well developed, reaching about 2.5 times beyond tip of rostrum. Outer margin strongly concave proximally with small basal spine followed by 1 much larger, longer spine and 2 small distal spines; upper part bearing 24 small teeth followed by considerable non-serrate distance up to final large tooth. Dorsal surface bearing 2 distinct longitudinal carinae, inner side of medial carina with row of 33 spinules. Inner margin provided with 69 long plumose setae. Ventral surface with medial longitudinal row of spi-

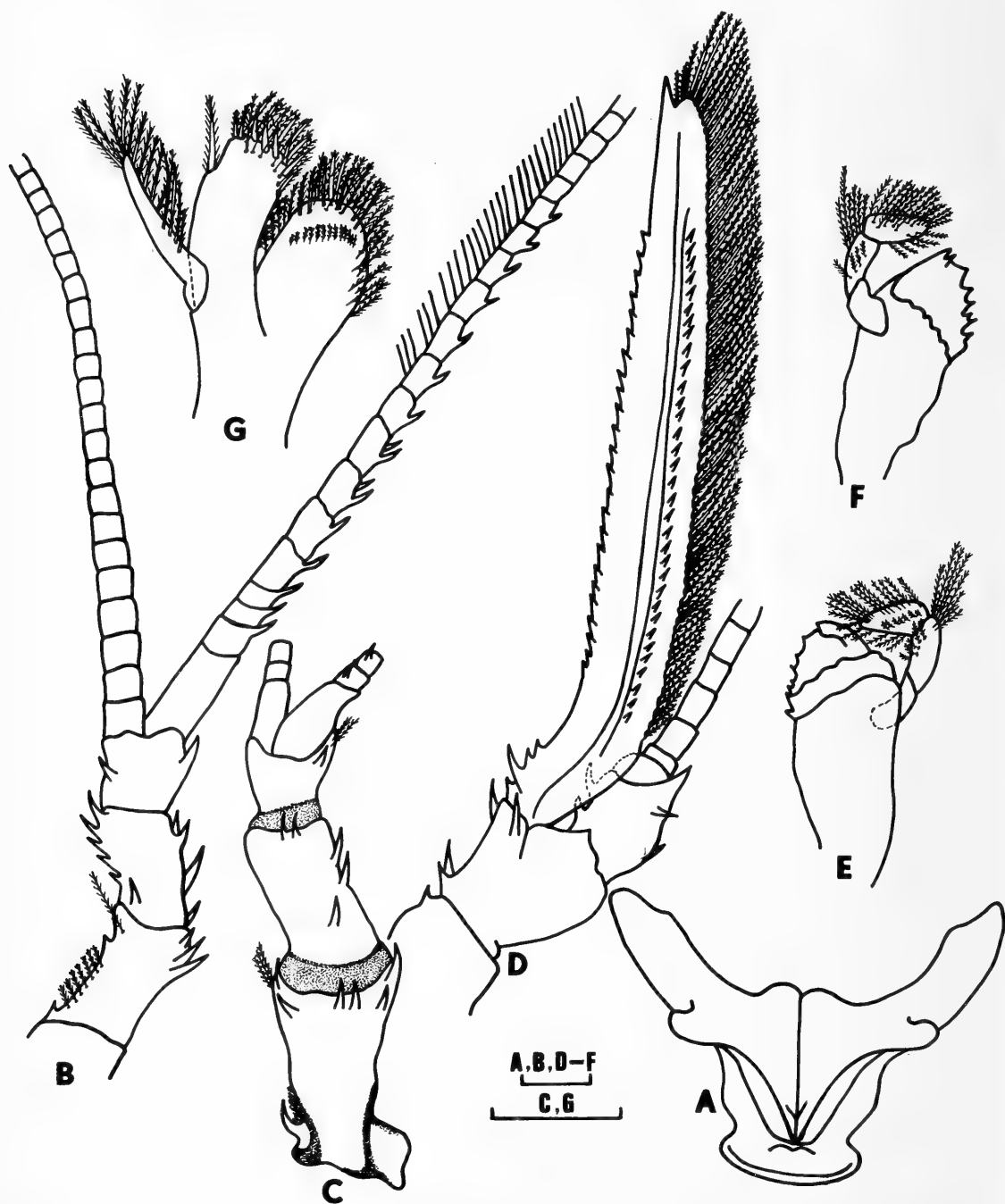


Fig. 3. *Stenopus pyrrsonotus*, holotype, male: A, Paragnath; B, Right antennule and antennular peduncle, ventrolateral view; C, Left antennular peduncle, dorsal view; D, Antenna and scaphocerite, dorsal view; E, Mandible, ventral view; F, Mandible, dorsal view; G, Maxillule. Scale bars represent 1.0 mm.

nules (not shown). Antennal flagellum well developed, extending beyond tip of telson.

Mandible (Figs. 3E, F) robust with short, fused molar and incisor processes. Molar surface with few minute irregular teeth, incisor bearing 9

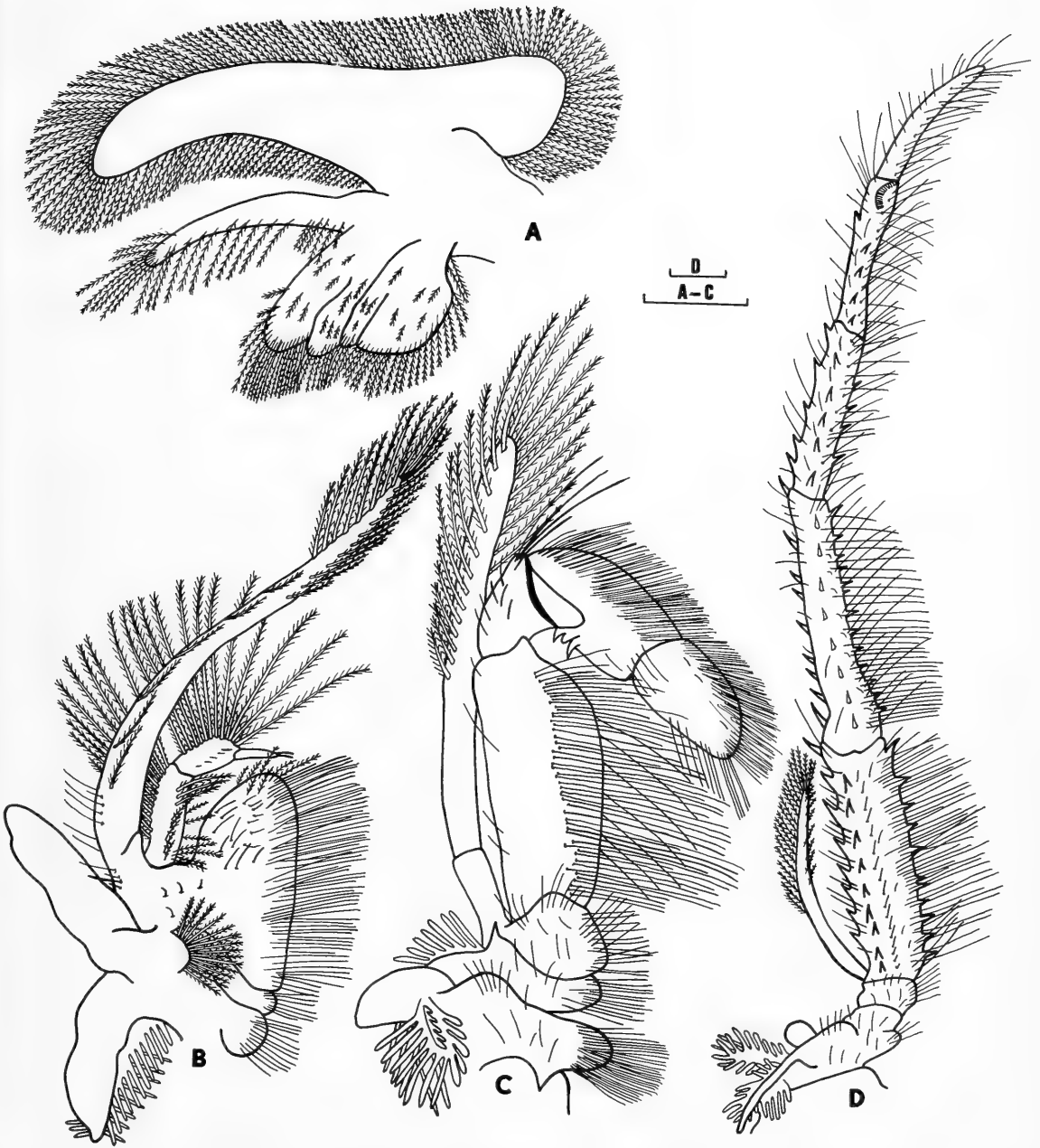


Fig. 4. *Stenopus pyrrsonotus*, holotype, male: A, Maxilla; B, First maxilliped; C, Second maxilliped; D, Third maxilliped. Scale bars represent 1.0 mm.

small medial teeth. Palp well developed, 3-segmented. Proximal segment without setae; middle segment about one-third longer than proximal segment bearing 4 small lateral setae, groups of large distal setae; distal segment broad, densely covered with setae laterally and distally.

Maxillule (Fig. 3G) with slender undivided endopodite about 6.5 times longer than broad, bearing 14 plumose setae on lateral border and distally. Proximal endite moderately broad, somewhat truncated distally with con-

spicuous seta laterally, 15 simple setae distally, few simple setae on lower inner border. Distal endite broader, rounded distally, bearing numerous simple setae, few short setae laterally.

Maxilla (Fig. 4A) with following setation on coxal and basal endites: 27 on proximal lobe, 7 on distal lobe of coxal; 14 on proximal lobe, 23 on distal lobe of basal. Endopodite long, slender, not exceeding anterior margin of scaphognathite, with 16 lateral plumose setae, 10 distal plumose setae. Scaphognathite long, narrow, with 143 plumose setae along margin.

First maxilliped (Fig. 4B) bearing 3-segmented endopodite. Proximal segment long, 2.5 times as long as broad, with 12 long plumose setae laterally, 15 shorter setae on inner margin. Middle segment about 0.7 times length of proximal segment, with 12 long plumose lateral setae, 5 minute simple mesial setae. Distal segment slender, tapering, slightly shorter than middle segment, with 2 minute simple terminal setae. Basipodite large, rounded anteriorly with straight outer border bearing dense fringe of long setae. Coxopodite bilobed, with each lobe bearing numerous short setae; proximal lobe partly covered by 15 short plumose setae. Exopodite well developed, flagellum arising from incomplete peduncle, bearing 6 short plumose setae proximomesially, 24 longer plumose setae distally. Large epipod with moderately slender proximal and distal lobes.

Second maxilliped (Fig. 4C) with 7-jointed endopodite. Dactylus suboval, twice as long as broad, with dense fringe of short setae along distodorsal margin, 12 short setae along distoventral margin. Propodus about 1.5 times length of dactylus, densely setose on dorsal margin, ventral margin bearing 3 stout proximal teeth. Carpus short, triangular about 0.5 times length of propodus, with 4 long simple setae at distodorsal angle, 6 shorter simple setae mesially and laterally. Merus almost 2.0 times length of dactylus, 2.5 times longer than broad, with straight inner border bearing 4 simple evenly spaced setae; outer border convex with many long simple setae; outer part distinctly more compressed and broader than inner part. Ischium and basis not fused, each with dense mesial setae as for coxa; ventral side of ischio-basis with distinct projection. Exopodite long, slender, undivided with distal half bearing 23 long plumose setae. Small epipod present.

Third maxilliped (Fig. 4D) endopodite strongly developed, 7-segmented. Dactylus slender, tapering, about 6.5 times longer than basal width, with 14 simple setae on outer margin, 19 simple setae mesially and on inner margin. Propodus same length as dactylus but about 5.0 times longer than broad, bearing 1 acute spine, few long and short simple setae on outer margin; 4 spines medially; setiferous organ distally; numerous long simple setae along inner margin. Carpus slightly longer than propodus, about 4.5 times longer than broad, with 5 spines, 7 long setae on outer margin; row of 5 spines medially; 4 small spines, numerous long simple setae on inner margin. Merus long, slender, 1.5 times longer than carpus, with 9 large spines on ventral



outer margin; row of 8 spines medially; 13 small spines, long setae densely covering inner margin. Ischium robust, flattened, 0.9 length of merus, with row of 7 large spines, 17 spaced setae, large submarginal distal spine on outer margin; mesial row of 9 large spines, 18 short medial setae; 11 large spines covered by dense fringe of long setae on inner margin. Basis short, rounded, with 5 long setae on inner margin, laterally bearing well developed exopodite almost equal to ischium length with 28 plumose setae on distal half. Coxa short, with small lobe bearing 3 setae on inner margin; laterally epipod slender, tapering with solid rounded coxal lobe dorsally.

First pereopod (Figs. 5A, B) small, slender, when stretched reaching just past scaphocerite, all segments generally glabrous. Dactylus less than half length of propodus. Fingers slightly compressed, having somewhat hooked tips. Cutting edges indistinct with only dactylus bearing chitinous ridge along inner margin. Dactylus covered with numerous short simple setae, propodus covered with numerous short and long simple setae. Fingers and distodorsal extremity of palm bearing small tufts of long setae. Distoven-tral part of carpus and proximoventral part of propodus provided with setiferous organ. Carpus longest segment about 1.3 times length of propodus, narrowing slightly proximally. Merus about 0.8 times length of carpus, ischium about of equal length, both bearing numerous short and long simple setae. Basis short, bearing 5 ventral setae; coxa stout, unarmed, but bearing small epipod.

Second pereopod (Figs. 5C, D) similarly built as first, but longer, stronger. No setiferous organ present. Finger tips more strongly hooked than first, cutting edges each with small rounded proximal tooth, dactylar tooth slightly in advance of one on propodus; also edges provided with 18 small, stout, peg-like teeth separated by rectangular chitinous lamellae. Fingers and distodorsal extremity of palm bearing small tufts of long setae, surfaces of dactylus, propodus covered with few simple setae. Carpus same length as propodus, slightly longer than merus or ischium, bearing 8 dorsal spines, generally covered with numerous long setae. Merus, ischium of equal length about 0.7 times length of carpus, with merus bearing 9 curved spines, 16 long setae dorsally; ischium with few long setae. Basis short with 4 ventral setae; coxa stout with small epipod.

Third pereopod (Fig. 5E) largest, strongest, longer than entire length of body, extending beyond scaphocerite by half length of merus and length of carpus and chela. Palm of chela longest segment with dorsal row of 23 strong forward curved spines, below this 15 smaller spines dorsomesially, followed by median groove with 17 similar sized spines. Ventral margin bearing 26 strong forward curved spines, 15 smaller spines ventromesially, less distinct row of 11 small spines on outer side. Between dorsal, ventral marginal spines numerous long simple setae. Fingers elongate, with sharp hooked crossing tips. Dactylus bearing 10 dorsal acute spines, 3 smaller spines dor-



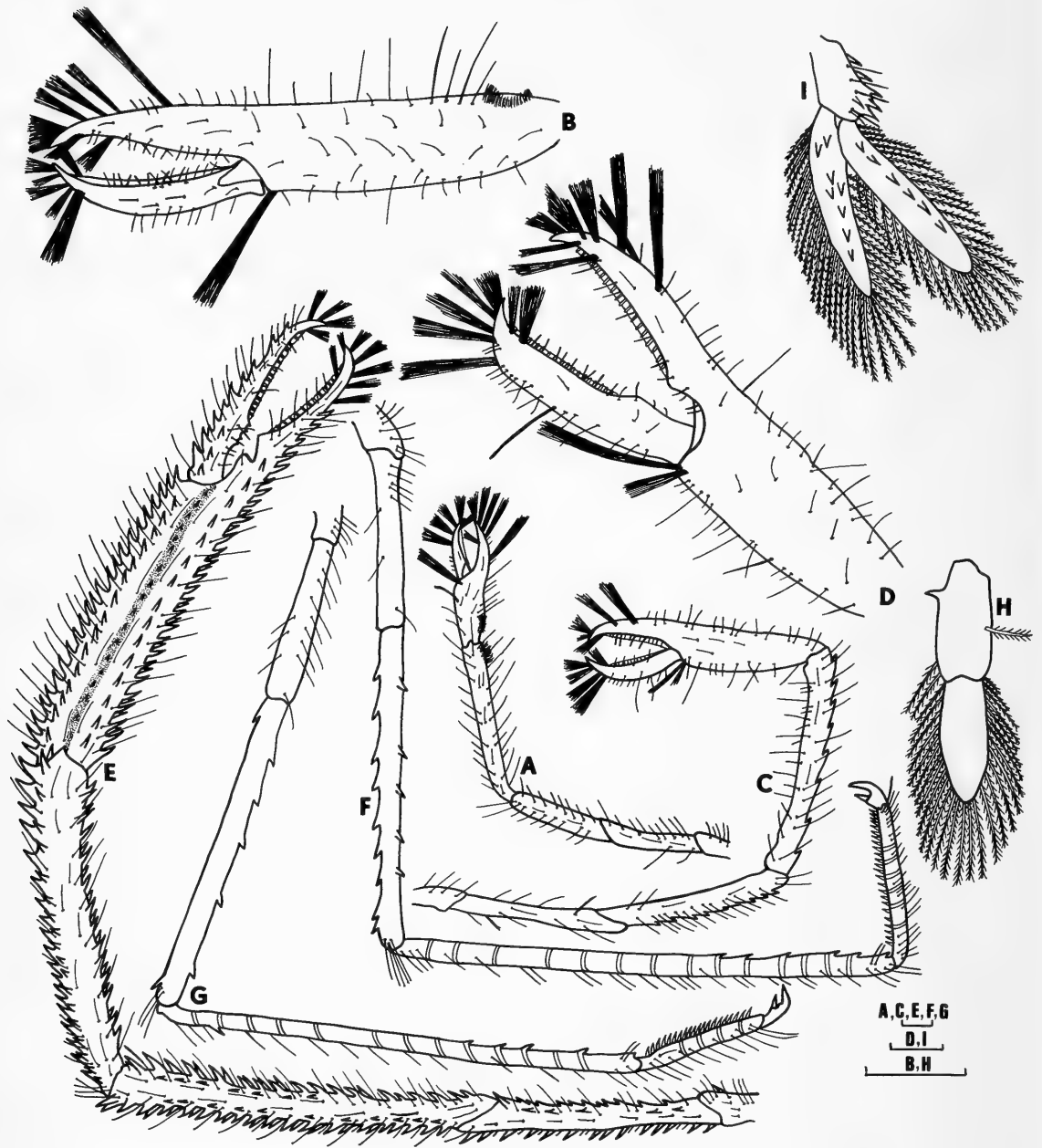


Fig. 5. *Stenopus pyrronotus*, holotype, male: A, First pereiopod; B, Chela of first pereiopod; C, Second pereiopod; D, Chela of second pereiopod; E, Third pereiopod, mesial view; F, Fourth pereiopod; G, Fifth pereiopod; H, First pleopod; I, Second pleopod. Scale bars represent 1.0 mm.

somesially at proximal end, numerous long simple setae. Dactylar cutting edge bearing 4 small sharply pointed teeth proximally merging into row of 14 stout, peglike teeth separated by rectangular chitinous lamellae. Cutting edge of propodus with large blunt tooth, more acute tooth proximally, opposing 4 small proximal dactylar teeth; also distally bearing 14 peglike teeth separated by chitinous lamellae. Fingers distally bearing small tufts of long

setae. Carpus about 0.3 times shorter than propodus narrowing gradually proximally. Dorso-outer margin bearing 19 spines, 18 smaller spines dorsomesially; ventral margin with 13 spines, less distinct row of 10 small spines ventromesially. Scattered long setae on dorsal, mesial, outer, and ventral margins. Merus almost as long as propodus, narrower than carpus, with dorso-outer row of 19 large spines, 11 smaller spines dorsomesially, 11 large spines on inner side. Ventral margin with 17 large spines, 7 smaller spines ventromesially, 8 spines on outer side. Numerous long setae interspaced between dorsal, ventral marginal spines. Ischium short, about half length of propodus with 14 spines on inner side, 12 spines on ventral margin, 5 ventromesial spines, few short simple setae. Basis and coxa short, fragile with 1 small spine and 5 spines respectively on ventral margins, few short setae, small epipod.

Fourth, fifth pereopods (Figs. 5F, G) long, slender, very similar. Dactylus of fourth biunguiculate with unguis long, curved, not clearly separated from dactylar corpus; accessory spine short, straight, about half length of unguis. Propodus subdivided into 7 segments bearing 25 movable ventral spines, 23 long dorsal setae. Carpus slender, straight, longest segment of pereopod, subdivided into 15 smaller segments with 6 small spines on distoventral margin of distal 7 segments; 29 long, well spaced, unbranched setae. Merus slender, elongate, with 5 ventral spines, 9 dorsal spines, 5 long setae at distodorsal extremity. Ischium, basis unarmed except for few long setae. Coxa ventrally bearing large distal spinule, 2 smaller proximal spinules. Fifth pereopod with similar dactylus as fourth, but unguis not as long with small distal ridge. Propodus subdivided into 5 segments with 20 movable ventral spines, 12 long dorsal setae. Carpus longer than fourth pereopod's, subdivided into 14 segments with 5 small distoventral spines on distal 5 segments, 1 proximal dorsal spine, 16 long dorsal setae. Merus with 5 ventral spines, 1 proximal and distodorsal spine, 4 long setae at distodorsal extremity. Ischium, basis unarmed except for few long setae; coxa bearing 3 ventral spinules.

First pleopod (Fig. 5H) uniramous, second (Fig. 5I) to fifth biramous, all lacking appendices. First pleopod smallest, with exopodite equal in length to basipodite. Dorsal margin of basipodite with single mid-proximal spine, 2 distal plumose setae; ventral margin with median plumose seta. Exopodite bearing 28 plumose marginal setae. Rami of second pleopod about twice length of basipodite. Ventral margin of basipodite bearing 5 spines, 4 simple setae; 1 spine ventromesially. Ventral surface of exopodite bearing row of 6 spines, 30 plumose marginal setae; that of endopodite with 8 spines, 36 plumose marginal setae. Third to fifth pleopods generally similar, decreasing in size, spinulation posteriorly.

Branchial formula:

	Maxillipeds			Pereiopods				
	I	II	III	I	II	III	IV	V
Pleurobranchs	—	1	1	1	1	1	1	1
Arthrobranchs	—	1	2	2	2	2	2	—
Podobranchs	—	1	—	—	—	—	—	—
Epipods	1	1	1	1	1	1	1	—
Exopods	1	1	1	—	—	—	—	—

Measurements: The measurements of the holotype are included in Table 1 and compared with other specimens examined.

Coloration: The carapace, eyestalk, antennular peduncle, antennal scale, and rostrum are a pinkish-white. The antennal flagella are all completely opaque white. The third maxillipeds are a translucent pink. The coxae, basises, ischia and meri are translucent pink on all the pereiopods, and the rest of these appendages are opaque white. The abdomen is largely white except for a red central stripe covering about one third of the dorsal surface and extending from the first abdominal somite to the sixth somite (often with a very narrow central white portion) becoming broader by the third abdominal somite. The telson is white and the uropods are a translucent pink.

Allotype: (female, USNM 173918). Generally similar to holotype, but differing in the following respects. The rostrum has 7 dorsal, 2 ventral, 3 left lateral, and 4 right lateral teeth. The telson's longitudinal carinae each bearing 7 strong spines. The mouthparts were removed from the right side, but show no major differences. The dactylar cutting edge of the third pereiopod has the 4 proximal teeth coalesced into one large sharp tooth. There are no ventral median spines present on the abdominal somites. The first pleopod is not shorter relative to the rest and the exopodite is narrow and acuminate, longer than the basipodite, which lacks the proximal spine on its outer margin.

Paratypes: The new species is variable in the number of body and appendage spines. For example, our specimens showed the rostrum with from 5–7 dorsal, 1–7 ventral, and 0–4 lateral spines (Fig. 6). The number of spines on the proximal part of the outer margin of the scaphocerite in our material varies from 2 to 4, while the number on the distal part varies from 15 to 30. The third maxilliped sometimes has a small spine proximal to the setiferous organ. The first and second pereiopods sometimes have short proximal spinules on their ischia and basises. Some specimens have minute peglike teeth separated by chitinous lamellae on the cutting edge of the first pereiopod. The basipodite of the first pleopod has 0–3 spines. We could not find any correlation between the number of spines and the size or sex of the animals, but some of these differences probably reflect allometric growth changes and the normal variation in the species. Some specimens have the carapace and proximal parts of the walking legs tan or light golden brown.

Table 1.—Meristic data and correlation between carapace, third pereiopod, and total length in *Stenopus pyronotus* sp. nov. (measurements in mm).

	Specimen	*										**				
		BPBM S8580	BPBM S8287	BPBM S8578	BPBM S8494	BPBM S8577	USNM 173917	USNM 173919	BPBM S8579	BPBM S7887a	BPBM S8493b	USNM 173918	BPBM S8491	BPBM S7887b	BPBM S8493a	BPBM S8495
(1)	Total length	28.2	30.0	30.0	34.0	41.5	47.0	48.7	51.5	52.5	52.5	53.0	58.0	59.0	62.0	73.0
(2)	Rostral carapace length	10.0	10.7	11.3	12.0	14.5	15.0	15.5	15.5	21.0	19.0	18.0	20.0	21.5	21.0	29.0
(3)	Post-orbital carapace length	6.0	6.5	7.1	8.0	9.0	10.0	10.5	8.5	14.5	13.2	12.2	12.2	14.5	15.0	21.0
(4)	Third pereiopod dactylus length	3.9	4.4	5.0	5.2	9.0	8.0	7.2	10.0	10.0	11.5	7.5	12.0	15.0	11.0	14.0
(5)	Third pereiopod propodus length	12.0	13.0	13.5	17.0	24.0	19.3	19.2	21.5	24.0	29.0	20.0	29.3	39.0	37.0	50.0
(6)	Third pereiopod carpus length	9.8	9.5	9.5	11.0	15.0	13.5	13.6	—	15.0	16.0	12.0	19.2	20.0	20.0	24.0
(7)	Third pereiopod merus length	11.0	11.0	10.0	14.0	16.2	12.0	13.0	18.5	18.0	19.0	14.3	20.0	23.5	22.0	34.0
(8)	Third pereiopod ischium length	7.0	7.0	7.1	9.0	12.0	10.0	9.5	13.0	13.5	14.0	10.8	12.5	—	15.5	18.0
(9)	Third pereiopod total length (5–8)	39.8	40.5	40.1	51.0	67.2	54.8	55.3	—	70.5	78.0	57.1	81.0	—	94.5	126.0
Ratio	(9)/(3)	6.6:1	6.2:1	5.6:1	6.4:1	7.5:1	5.5:1	5.3:1	—	4.9:1	5.9:1	4.7:1	6.6:1	—	6.3:1	6.1:1
Ratio	(9)/(2)	4.0:1	3.8:1	3.5:1	4.3:1	4.6:1	3.7:1	3.6:1	—	3.4:1	4.1:1	4.7:1	4.1:1	—	4.5:1	4.3:1
Ratio	(9)/(1)	1.4:1	1.4:1	1.3:1	1.5:1	1.6:1	1.2:1	1.1:1	—	1.3:1	1.5:1	1.1:1	1.4:1	—	1.5:1	1.7:1
Ratio	(1)/(2)	2.8:1	2.8:1	2.7:1	2.8:1	2.9:1	3.1:1	3.1:1	3.3:1	2.5:1	2.8:1	4.3:1	2.9:1	2.7:1	3.0:1	2.5:1

\* Holotype. \*\* Allotype.

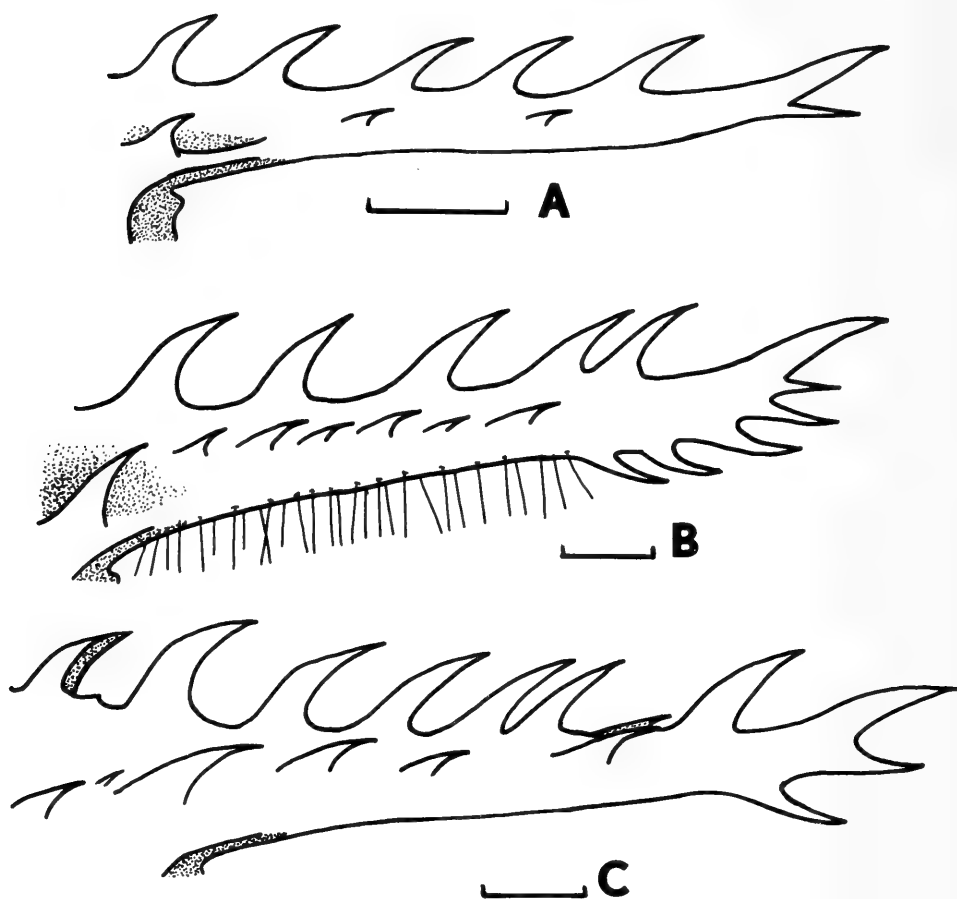


Fig. 6. *Stenopus pyrronotus*, paratypes: A, Rostrum BPBM S8577; B, Rostrum BPBM S7887; C, Rostrum BPBM S8491. Scale bars represent 1.0 mm.

A large ovigerous specimen (BPBM S8493) has a medial ventral abdominal spine present on each segment except the sixth which bears 2 spines. A juvenile character of the new species is the absence of pleopods on the first abdominal segment in specimens with rostral carapace length less than 11 mm or post-orbital carapace length less than 7 mm (BPBM S8287, S8580).

*Type locality*.—Hawaiian Islands, Oahu, west coast off Pokai Bay.

*Habitat*.—Most of the specimens were taken in crevices, caves, or under ledges on well developed coral reef systems. This cryptic behavior is also exhibited by other members of the genus. In at least 2 observations, the new species was found with a large green-bordered moray eel, *Gymnothorax flavimarginatus*. The specimen from Pada Bay, a juvenile, was one example seen with an eel, but other large specimens were also said to have been seen with this eel species (G. M. Ludwig, written communication). These observations and the fact that these shrimp have long prominent white antennal flagella, may indicate that the new species enters into cleaning symbiosis with cooperating fish, much like its congener, *Stenopus hispidus*.

*Etymology*.—The specific name is derived from the Greek “pyrsonotos” meaning red-backed; it is given because of the distinctive deep red stripe on the dorsal surface of the abdomen.

*Remarks*.—The new species, *Stenopus pyrsonotus*, follows closely the definition of the genus *Stenopus* Latreille given by Holthuis (1946), only differing in the absence of the lateral spines on the telson. This character separates it from all other species in the genus. It is most closely related to *S. hispidus*, but differs in color, rostrum, telson and the body spines being less erect.

Key to the Described Indo-West Pacific  
Species of *Stenopus*

- 1. Lateral marginal spines absent on telson; abdominal somites with broad mid-dorsal red stripe ..... *S. pyrsonotus* sp. nov.
- Lateral marginal spines present on telson; abdominal somites otherwise pigmented ..... 2
- 2. Outer margin of scaphocerite serrate up to final (terminal) tooth; abdomen with oval red patches on lateral sides of second and fifth somites ..... *S. zanzibaricus* Bruce, 1976
- Outer margin of scaphocerite with considerable nonserrate space before final (terminal) tooth; abdomen otherwise pigmented ..... 3
- 3. Rostrum exceeding antennular peduncle in length, with 2–9 ventral spines; abdomen with red transverse bands on third and fifth somites ..... *S. tenuirostris* De Man, 1888
- Rostrum not exceeding middle segment of antennular peduncle in length, without ventral spines; abdomen with red transverse bands on third and sixth somites ..... *S. hispidus* (Olivier, 1811)

Two species of stenopodidean shrimp have so far been reported from the Hawaiian Islands, *Stenopus hispidus* (Rathbun, 1906; McNeill and Ward, 1930; Edmondson, 1946; Tinker, 1965; Hobson and Chave, 1972; Titcomb *et al.*, 1979) and *Spongicola henshawi* (Rathbun, 1906). *Stenopus hispidus* has also been recorded from Mauritius (White, 1847; Hoffmann, 1874) along with many Indo-Pacific and Western Atlantic records reported by Holthuis (1946). The only other stenopodidean shrimp recorded from Mauritius belong to the genus *Microprosthema*. Richters (1880) reported *Microprosthema validum*, *M. scabricaudatum* and *M. plumicorne* from Île aux Fouquets, Mauritius. *Stenopus tenuirostris* is moderately common on western Indian Ocean reefs according to Bruce (1976). It has also been reported from numerous Indonesian localities (Holthuis, 1946), the Seychelles and Coetivy Islands (Borradaile, 1910), the Solomon Islands (Yaldwyn, 1968) and New Caledonia (Monod, 1976). *Stenopus zanzibaricus* was reported on the basis of a single specimen taken from Mwemba Island off Zanzibar (Bruce, 1976), but one of us (JWG) has examined another small male (total length 19.0 mm) collected from Canton Island (USNM 181402).

A specimen of yet another new species of *Stenopus* was recently collected off Makua, Oahu. This was an ovigerous female (total length approx. 24 mm) that differs in coloration and numerous morphological characters from *S. hispidus* and *S. pyrrsonotus*. Preliminary comparison with other descriptions indicates a closer relationship to the Western Atlantic *S. scutellatus*, and a full description will be presented in a forthcoming publication.

### Acknowledgments

We are grateful to Dr. John E. Randall, of the Bernice P. Bishop Museum, who made it possible to examine several specimens of *Stenopus pyrrsonotus* he collected and for providing the photograph of the new species taken off the west coast of Oahu.

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## ONUPHIDAE (POLYCHAETA) FROM BELIZE, CENTRAL AMERICA, WITH NOTES ON RELATED TAXA

Kristian Fauchald

*Abstract.*—Material collected at Carrie Bow Caye and other locations in Dangriga district, Belize, can be assigned to the following taxa: *Americonuphis magna* (Andrews), *Diopatra cuprea* (Bosc), *Onuphis* (*Nothria*) *dangrigae*, new species, *Onuphis* (*Onuphis*) *geminata*, new species, *O.* (*O.*) *pulchra*, new species, and *O.* (*O.*) *virgata*, new species. *O.* (*N.*) *intermedia* Kinberg, *O.* (*N.*) *veleronis*, new name, *O.* (*O.*) *fragilis* Kinberg, and *O.* (*O.*) *lineata*, new name, are discussed based on examination of the type materials.

### Introduction

Twenty species of onuphid polychaetes are presently known from Gulf of Mexico and the Caribbean Seas (Table 1). Of these, about half are known only from waters deeper than 200 m, at least as far as their distribution in this region is concerned. The family appears poorly represented in shallow water and intertidal areas here compared to regions at similar latitudes in the eastern Pacific Ocean (Fauchald, 1968; Hartman, 1968). Especially striking is the dearth of species of *Diopatra* in shallow water. Members of the genus *Onuphis* are frequent in slope and bathyal depths, whereas *Diopatra* is more species-rich in the shallows of the warm water regions of the eastern Pacific Ocean and in the Mediterranean Sea (Fauvel, 1923; Fauchald, 1972). Paxton (1979) demonstrated, however, that members of the genus *Onuphis* are common in shallow water in Australia.

The discrepancy in representation of the two genera between the eastern Pacific Ocean and the Western Atlantic, could be caused by differences in collecting efforts; however, the presence of four new species of *Onuphis* in very shallow water in Belize, without a corresponding increase in the number of species of *Diopatra*, tends to affirm the preliminary impression of a large-scale difference in the number of shallow water species in the two genera between the two oceans.

The material was collected as part of the Smithsonian Institution's *Investigation of Marine Shallow Water Ecosystems* (IMSWE-program) coordinated by Dr. Klaus Ruetzler. A series of individual collections were made by Drs. Meredith L. Jones (stations marked CB-1 through CB-41C), Joan D. Ferraris (st. JDF-24-1), Brian F. Kensley (K-44 and K-48) and the author (F-9 through F-33). Most specimens were collected by hand or with shovel, narcotized using oil of cloves, fixed in approximately 4% formaldehyde in



sea water neutralized with hexamine and transferred to 70% ethyl alcohol for storage. All material is deposited in the collections of the National Museum of Natural History, Smithsonian Institution, Washington, D.C. Types of other species were borrowed from Riksmuséet, Stockholm, Sweden and from the Allan Hancock Foundation, University of Southern California, Los Angeles.

#### Station List

Collected by Kristian Fauchald

- F-9. 12 April 1979. Carrie Bow Caye, north of the island, sand and small rubble, 30–60 cm depth.
- F-19. 23 October 1979. Carrie Bow Caye, southwest of island, *Thalassia* and sand, coarse-screened in 2 mm screen.
- F-21. 28 October 1979. Carrie Bow Caye, east of island, about 3 m inside inner edge of *Thalassia*-bed, 30–40 cm depth, coarse-screened in 2 mm screen.
- F-28. 4 November 1979. Carrie Bow Caye, east of island, about 60 feet from shore, *Thalassia* and sand, about 50 cm depth. Coarse-screened in 2 mm screen.
- F-33. 8 November 1979. Carrie Bow Caye, north of island, *Thalassia*, sand and rubble, 60 cm depth.

Collected by Joan D. Ferraris

- JDF-24-1. 30 April 1975. Carrie Bow Caye, lagoon, sand patch N of dock, 30 cm, shovel and ¼ inch mesh screen.

Collected by Meredith L. Jones

- CB-1. 4 April 1976. Carrie Bow Caye, sparse *Thalassia* just west of island, 1 m depth.
- CB-2. 5 April 1976. Carrie Bow Caye, northwest of island, general transect from bare sand area to coral rubble, .5 to 1.5 m depth.
- CB-3. 5 April 1976. Carrie Bow Caye, east of laboratory, sand areas mixed with coral rubble, just inside reef crest, about 1 m depth.
- CB-6. 6 April 1976. Carrie Bow Caye, sieved from sandy areas at top of intertidal around island, less than 30 cm depth.
- CB-7. 6 April 1976. Carrie Bow Caye, associated with old conch shell and sand, on southwest edge of island, 30 cm depth.
- CB-8. 6 April 1976. Carrie Bow Caye, east side of island, associated with coral pieces at water edge and above.
- CB-11. 7 April 1976. Carrie Bow Caye, 100 m north northeast of island, associated with *Acropora curvicornis* rubble, stagnated overnight.
- CB-14. 9 April 1976. Carrie Bow Caye, back side of reef crest, coral rubble, stagnated overnight.
- CB-16. 11 May 1977. Carrie Bow Caye, sparse *Thalassia*.
- CB-18. 11 May 1977. Carrie Bow Caye, 100 m southwest of island, sieved from coral rubble.
- CB-23. 12 May 1977. Carrie Bow Caye, sand immediately behind inner reef crest at far side of flat, northeast of laboratory.
- CB-28. 13 May 1977. Carrie Bow Caye, northwest of island, near inner end of permanent transect, *Thalassia*, apparent luxuriant growth, but no compact rhizome masses, coarse sand, 1–1.5 m depth.

- CB-34. 14 May 1977. Carrie Bow Caye, 100 m north of island, 1.5 m depth.
- CB-40A. 16 May 1977. Halfway between Colson Point and Salt Creek, Dangriga district, *Thalassia*, fine sand, almost mud, 1 m depth.
- CB-40B. 16 May 1977. Halfway between Colson Point and Salt Creek, Dangriga district, bare sand from .5 m depth to shore, much warmer water toward shore, about 15 cm depth. Fine sand, almost mud.
- CB-41C. 17 May 1977. Commerce Bight Pier, Dangriga district, transect over 75–80 m, from 1.5 m depth to shore, at 1.5 m soft brown mud over more compact black mud.

Collected by Brian F. Kensley.

- K-44. 8 April 1979. Twin Cayes, rocks and coral rubble, 30 cm depth.
- K-48. 10 April 1979. Carrie Bow Caye, coarse calcareous sand in upper spur and groove zone, no rubble or algae included, 1 m depth.

The terms applied to the morphological features are by and large the same used by Hartman (1944a) and Fauchald (1968). Some clarification of structural relations in the parapodia may be useful. In anterior parapodia 2–4 acicula support an *acicular lobe* which usually is distally truncate or rounded. The *presetal lobe* which is anterior to the acicular lobe, is usually a low fold that follows the outline of the acicular lobe closely; it is however frequently cut away on the ventral side leaving the acicular lobe exposed (Fig. 1b). The *postsetal lobe* usually has a broad, somewhat flattened base and a digitate or clavate distal part, extending well beyond the acicular lobe (Fig. 1b and others). The anterior parapodia can be extended or retracted. In the latter condition a contraction fold (Fig. 3b) may develop across the parapodium. This fold is normally at the base of either the dorsal or ventral cirrus or both. The contraction fold, called the low transverse fold, was treated, undeservedly, as a structural feature by Fauchald (1968); its presence depends entirely on the state of contraction of the parapodium and while its presence is interesting it is not of any great taxonomic importance.

The acicula are thick gently tapering rods inside the body; at emergence they are bent and taper abruptly to fine, needle-like tips.

The setal distribution in the anterior parapodia vary somewhat, but in general two distinct fascicles of setae can be recognized. Above and in front of the acicula (*i.e.* in a superior preacicular position) is found a fascicle of tapering, limbate setae. Below and slightly inferior to the acicula (*i.e.* in an inferior, postacicular position) are found pseudocompound hooded hooks. A single simple seta may be present directly below the acicula. If compound spinigers are present, these are always ventral, usually distinctly posterior to the acicula. The limbate setae shift to postacicular positions by setiger 20 in most species; they remain above the acicula in anteromedian setigers, but are directly behind the acicula in posterior setigers.

Several different kinds of hooks may be present; in this paper are treated species with three different kinds. In anterior setigers, usually in 2 to 5

setigers, are found *pseudocompound hooded hooks*. These hooks may be distally entire and falcate, or, more usually, bi- or tridentate. Most species have usually a single sort of hook, either uni- bi- or tridentate, but some have two sorts of hooks (*e.g.* both bi- and tridentate).

Another kind of hook may also be present in some anterior setigers. The *large hooks* are always tridentate, are usually less distinctly compound and at least twice as thick-shafted as the pseudocompound ones in the same setiger. Both kinds of hooks can be present in the same setiger, but the large hooks are usually present in more setigers than are the pseudocompound ones.

A pair of bidentate, hooded *subacicular hooks* are present in all median and posterior setigers. Each hook originates above the base of the acicula, but emerges from the acicular lobe well below the acicula, thus the trajectory of the subacicular hook forms a distinct angle with that of the acicula.

It is possible to have both pseudocompound and large hooks in the same setiger as mentioned above; likewise, compound spinigers and large hooks may occur in the same setiger. However, pseudocompound hooks and compound spinigers do not occur in the same setiger. Both compound spinigers and large hooks usually terminate before the start of the subacicular hooks. One or several segments without any kinds of hooks may be present between the last large and the first subacicular hook.

*Pectinate setae* are present in most median and posterior setigers. The distal edge may be at right angles to the shaft (transverse) or be at another angle with the shaft (oblique); the number of teeth vary from about 10 to more than 25.

The taxonomic treatment in this paper follows traditional lines with one exception; the inclusion of simple statistical tables demonstrating the patterns of variability within each species is unusual in the polychaete literature. A couple of interesting and potentially very important features emerged from this treatment. First, within a population variability is restricted, even over a two-year time span (*Onuphis* (*Onuphis*) *pulchra* at Carrie Bow Caye); second, in comparing different taxa, the same characters do not stay invariant for all taxa (*cf.* the different species of *Onuphis* (*Onuphis*) in the tables below). Two conclusions can be drawn. No single character can be used to discriminate among three or more taxa even when these are closely similar. The limited variation exhibited within a taxon from a single location emphasizes the necessity of extremely careful comparisons among various populations referred to the same taxon. A simple overlap in selected character states is insufficient to demonstrate identity between two populations and a much more exhaustive analysis must be performed in order to demonstrate such identity.

A character usually avoided in the polychaete literature is the color pattern. These patterns were found to be highly characteristic in the present

material and are described in some detail below; they have been omitted from the illustrations to avoid clutter. It should be noted that the color pattern was easily identifiable in alcoholic specimens.

Family Onuphidae Kinberg, 1865  
Genus *Americonuphis* Fauchald, 1973  
*Americonuphis magna* (Andrews, 1891)

*Diopatra magna* Andrews, 1891a:121, pl. 2, figs. 1–7; 1891b:286–287, pl. 14, figs. 14–20.—Wilson, 1900:351.

*Onuphis magna*.—Treadwell, 1921:78–81, pl. 7, figs. 1–5, textfigs. 279–287.—Pearse, 1936:181.—Hartman, 1944a:70; 1944b:21; 1945:24; 1951:51.—Day, 1973:54. ?Monro 1928:89. [Not Monro, 1933:76, nor Berkeley and Berkeley, 1939:336].

*Americonuphis magna*.—Fauchald, 1973:22.—Gardiner, 1976:193, fig. 25a–d.

*Material examined*.—CB-40A (1 specimen).

*Remarks*.—*A. magna* can be separated from the closely similar *A. reesei* Fauchald (1973) by the branchial structure and maxillary formula. *A. magna* has about 12 branchial filaments where the branchiae are best developed, *A. reesei* has, maximally, seven branchial filaments. The maxillary formula for *A. magna* is 1+1, 8+8, 6+0, 5+9 and 1+1; for *A. reesei* the formula is 1+1, 10+12, 14+0, 4+9 and 1+1 (this formula was incorrectly reported in Fauchald, 1973). The specimen reported as *Onuphis magna* by Berkeley and Berkeley (1939:336, USNM # 38269) has been re-examined and is here referred to *A. reesei*. Monro (1928) did not describe his specimen adequately so his record must be considered doubtful. There are currently no validated reports of *A. magna* from the eastern Pacific Ocean.

Gardiner (1976) pointed out that the generic name *Americonuphis* was applied independently by Orensanz (1974) to a different group of species. Paxton (1979:279) rectified the situation by renaming Orensanz's taxon *Australonuphis*.

*A. magna* is known from intertidal and shallow subtidal sand flats from North Carolina through the Caribbean Sea and the Gulf of Mexico.

Genus *Diopatra* Audouin and Milne Edwards, 1833  
*Diopatra cuprea* (Bosc, 1802)

*Nereis cuprea* Bosc, 1802:143–144 (illustrations published 1830).

*Diopatra cuprea*.—Pettibone, 1963:250–254, fig. 66a–e (and references therein).—Gardiner, 1976:185, fig. 23e–i.

*Diopatra cuprea cuprea*.—Day, 1967:417, fig. 17:12a–d; 1973:54.

*Material examined*.—CB-1 (11 specimens); CB-2 (2); CB-6 (1); CB-11 (1); CB-16 (1); CB-28 (6); CB-34 (2); CB-40B (3); CB-41C (5); F-9 (1); F-28 (1).

*Remarks.*—*D. cuprea* is usually described as being evenly reddish brown without distinct dorsal color pattern. Specimens from Belize differ in that they have scattered brown pigment spots over most of the dorsum and transverse dark brown bands at setiger 5 or setgers 5 and 6. Most specimens are small compared to specimens reported from more northerly locations.

*D. cuprea* is very similar to *D. ornata* Moore (see Hartman, 1968:659 for a description). The two can be separated by the structure of the anterior hooks. The proximal tooth of each pseudocompound hook is gently curved in *D. cuprea* and nearly parallel to the axis of the hook; it is strongly curved and nearly at right angles with the axis of the hook in *D. ornata* (Hartman, 1944a:54). There are also differences in the patterns of papillae on the ceratostyles. *D. cuprea* has papillae of two kinds, organized in 16–18 longitudinal rows, whereas *D. ornata* has same-sized papillae densely scattered over the ceratostyles (Hartman, 1944a:54–55). These characters were re-examined in the present collections; while somewhat obscure, they appear absolutely consistent.

*D. cuprea* has been reported from New England to Brazil in the Western Atlantic Ocean and along west Africa to the Indian Ocean. In view of the great similarity between *D. cuprea* and related species a careful examination of material from all parts of its range should be undertaken.

Genus *Onuphis* Audouin and Milne Edwards, 1833

Subgenus *Nothria* Malmgren, 1867

*Onuphis* (*Nothria*) *dangrigae*, new species

Figs. 1–2, Tables 2–3

*Material examined.*—CB-1 (1 specimen); CB-3 (9 paratypes, USNM 61225); CB-6 (4); CB-7 (10); CB-8 (1); CB-11 (3); CB-14 (1); CB-16 (2); CB-18 (1); CB-23 (1, holotype, USNM 61224); CB-28 (1); K-44 (2); K-48 (2 juveniles); JDF 24-1 (1).

*Description.*—The holotype is an incomplete specimen with 66 setigers that is 28 mm long and 1.5 mm wide with setae. Other, complete specimens have about 120–130 setigers and are about twice as long as the holotype, but no wider. All specimens are white and lack color patterns, as preserved. The anterior part of the body, including the first 5 setigers is cylindrical; in the rest of the body the dorsal side is strongly flattened and the ventral side convex. Two anal cirri are present.

The prostomium (Fig. 1a) is about as wide as long and has a pair of very small, black eyespots near the base of the frontal antennae. Each frontal antenna is triangular and slightly pustulate. The ceratophores of all 5 occipital antennae have 4 or 5 rings, of which the distalmost is much longer than any of the others. The outer lateral antennal styles reach the anterior margin of the second setiger; the inner lateral and median styles are similar in length

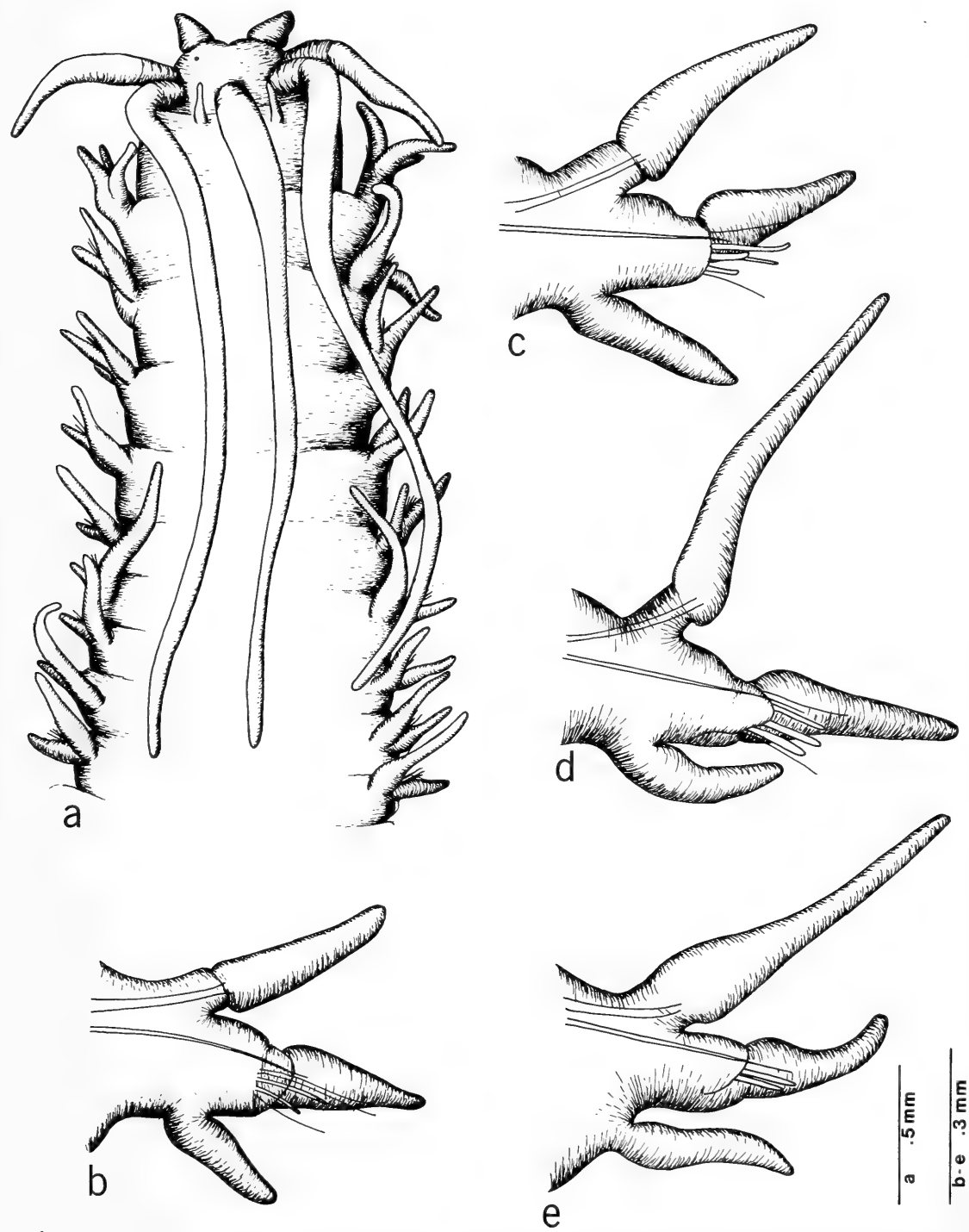


Fig. 1. *Onuphis (Nothria) dangrigae* (holotype, USNM 61224): **a**, Anterior end, dorsal view; **b**, Parapodium of setiger 1, anterior view; **c**, Parapodium of setiger 2, anterior view; **d**, Parapodium of setiger 3, anterior view; **e**, Parapodium of setiger 4, anterior view.

and reach the ninth or tenth setiger. The peristomium is about twice as wide as the prostomium and carries a pair of peristomial cirri near the anterior margin. Each cirrus is slender and barely reaches the middle of the prosto-

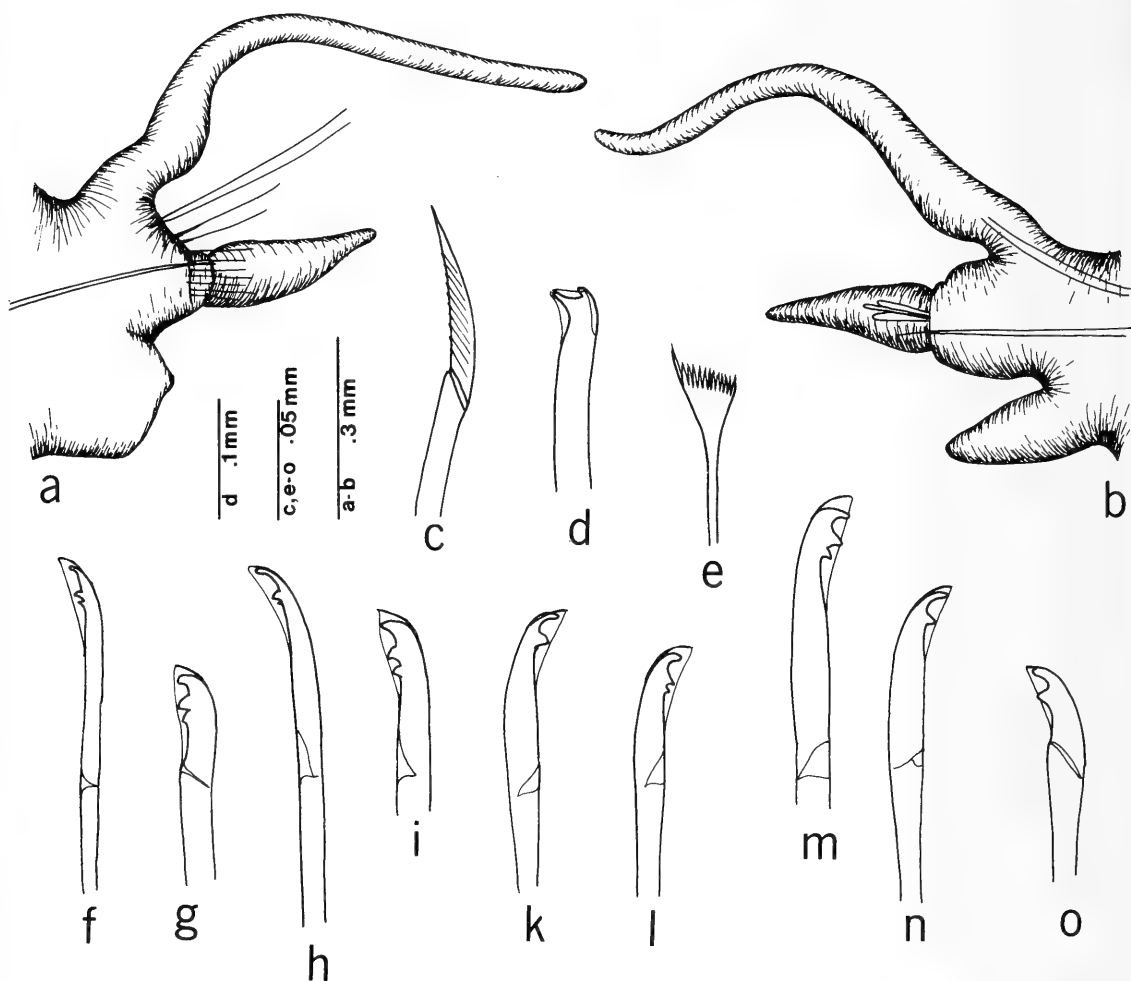


Fig. 2. *Onuphis (Nothria) dangrigae* (holotype, USNM 61224): a, Parapodium of setiger 6, anterior view; b, Parapodium of setiger 5, anterior view; c, Compound spiniger, setiger 6; d, Subacicular hook, setiger 50; e, Pectinate seta, setiger 50; f-o, Pseudocompound hooks, f-g, From setiger 1; h-i, From setiger 2; k-l, From setiger 3; m-n, From setiger 4; o, From setiger 5.

mium. The separation between the two peristomial rings is distinct on the ventral side, but cannot be seen on the dorsal side.

The parapodia are attached at the anterior edge of each of the 5 first setigers. The great development of basal parapodial muscles in each of these setigers makes each segment much wider anteriorly than posteriorly. The first 3 pairs of parapodia are directed obliquely forward and ventrally. Parapodium 4 is transitional; from parapodium 5 each parapodium is fully lateral in position and is situated at about the mid-length of each segment. Further posteriorly the parapodia take a position at the junction between the flat dorsum and the curved ventrum and in these segments the dorsal cirri appear to be attached directly to the dorsum. Each of the first parapodia (Figs. 1b-d) has a distally rounded acicular lobe; the presetal lobe is a low, transverse fold covering the bases of the setae. The postsetal lobe is clavate and

about as long as the parapodium from the base to the tip of the acicular lobe. The dorsal cirri have distinct cirrophores in the first 3 parapodia. Thereafter, the cirrophores are indicated only as thickenings near the base of each cirrus. The dorsal cirri double in length between the first and the sixth setiger (Figs. 1b–e, Fig. 2a–b) and then decrease slowly in length until in the last segments (in complete specimens) they are of about the same length as in the first setigers. The dorsal cirri decrease in width posteriorly and in far posterior setigers they are slender and nearly filamentous. Ventral cirri are distinctly cirriform through 4 or 5 setigers and are pad-shaped from setiger 6. The structure of the ventral cirrus in setiger 5 varies from a short, tapering cirrus, shorter, but similar in shape to those found in the first 4 setigers, to a glandular pad similar to the ones found in posterior setigers. In median parapodia the postsetal lobes decrease in size and are recognizable only as short papillae from about setiger 45.

Simple, flattened strap-like branchiae are first present from setigers 18–21.

Limbate and pectinate setae, pseudocompound bi- and tridentate hooks, compound spinigers and subacicular hooks are present. Limbate setae are sparsely present in all parapodia in the anterior one-third of the body. All acicula project beyond the tips of the acicular lobes as slender, slightly bent needles. The anterior 5 pairs of parapodia have pseudocompound hooks distributed in the following manner (examined in 5 specimens): In parapodium 1, 4 slender, tridentate hooks (Fig. 2f) with long appendages and one stout, tridentate hook (Fig. 2g) with short appendage. In parapodium 2, 3 slender, tridentate hooks (Fig. 2h) and 3 stout tridentate hooks (Fig. 2i). The proximal tooth is very small in all slender hooks and is difficult to see. In parapodium 3 the distinction between slender and stout hooks is absent, but 3 hooks (Fig. 2k) have slightly longer appendages than 2 others (Fig. 2l). The proximal tooth is much more reduced in hooks with long appendages than in those with short appendages. Parapodium 4 has 3 bidentate hooks (Fig. 2n) and a single tridentate one (Fig. 2m). In parapodium 5 there are 3 bidentate hooks (Fig. 2o); tridentate hooks are absent. Compound spinigers are found in subacicular positions from setiger 6 through the segment before the start of the subacicular hooks. Each spiniger (Fig. 2c) has a heterogomph articulation and a narrow, knife-edged blade with fine serrations. Subacicular hooks are first present from setigers 14–16, so the number of setigers with compound spinigers vary from 8 to 10. Each subacicular hook (Fig. 2d) is bidentate and has a distinct, short hood. Pectinate setae are present from setiger 6; each (Fig. 2e) is distally slightly oblique and has about 12 teeth. One side has a long spur.

The maxillary apparatus is poorly sclerotized. The maxillary formula is 1+1, 8+7, 7+0, 7+8 and 1+1 (based on the dissection of two paratypes). The mandibles are fused over most of their length.

The tubes consist of a thin, pliable inner lining and a loose cover of unsorted sand grains.



*Remarks.*—Other members of the subgenus *Nothria* with branchiae starting posterior to setiger 10 include *O. guadalupensis* (Fauchald, 1968:22–24, pl. 6, figs. e–l), *O. rubescens* Augener (1906:139–141, pl. 4, figs. 76–83), *O. stigmatis* Treadwell (1922:176–178, figs. 22–34, see also Hartman, 1944a:89–91, pl. 11, figs. 240–247) and two species, originally described as subspecies of the latter, *O. cirrata* (Hartman, 1944a:92–93, pl. 11, figs. 248–253) and *O. veleronis*, new name (for *Nothria stigmatis intermedia* Hartman, 1944a:93–95, pl. 15, figs. 315–324, see below). Table 2 surveys important differences among these species. The structure of the pseudocompound hooks in anterior setigers is of particular importance; of the species listed above, only *O. guadalupensis* and *O. dangrigae* have both bi- and tridentate hooks. *O. dangrigae* has ringed ceratophores, cirriform ventral cirri on 4 or 5 setigers, 5 setigers with pseudocompound hooks and lacks color patterns. *O. guadalupensis* has smooth ceratophores, cirriform ventral cirri on 3 setigers and 3 setigers with pseudocompound hooks; in addition, it has a color pattern of dark dorsal cross-bars on anterior setigers.

The most widely reported species listed in Table 2 is *O. stigmatis*. In order to investigate the relationships between *O. dangrigae* and *O. stigmatis* a number of specimens of the latter, collected at the type locality, were examined (USNM 33713, False Bay, San Juan Island, Washington, summer, 1937, coll. M. Miller, det. Marian H. Pettibone). The results of the comparison is given in Table 3. As can be seen, the number of segments with pseudocompound hooks vary somewhat in *O. dangrigae*, but averages 4.5, whereas it is invariant at 3 in *O. stigmatis*. In contrast, the number of cirriform ventral cirri is invariant at 5 in *O. dangrigae* and varies somewhat, but averages 3.5 in *O. stigmatis*. Both features imply that *O. dangrigae* has one more segment involved in the head-formation than does *O. stigmatis*. *O. stigmatis* also retains a distinct color pattern, even after more than 40 years in alcohol; such patterns are absent even in live specimens of *O. dangrigae*.

*O. dangrigae* is known from several localities near Carrie Bow Caye and Twin Cayes, Belize, in *Thalassia* beds, coral rubble, sand and shells in shallow water.

*Etymology.*—The specific name is derived from the name of the district in Belize in which Carrie Bow Caye and Twin Cayes are located, Dangriga in Carib, or Stann Creek in English.

*Onuphis (Nothria) intermedia* Kinberg, 1865

Table 2

*Onuphis intermedia* Kinberg, 1865:560; 1910:40, pl. 14, fig. 9.—Augener, 1931:296–297, fig. 5.

*Material examined*.—Atlantic Ocean, off the entrance to the harbor at Rio de Janeiro, 30–40 fms (holotype, Riksmuséet, Stockholm, marked E.E. 191 and type number 461).

*Remarks*.—The type-material consists of one anterior end of about 50 setigers that is 9 mm long and about 1 mm wide and three median fragments, which may belong to another species. The remarks are based on the anterior end except where noted. The occipital ceratophores have 4 to 5 rings; branchiae are present from about setiger 25 as single filaments and all branchiae are single on the anterior fragment. The largest midpiece has 2 to 3 branchial filaments on each segment. Cirriform ventral cirri are present on the first 5 setigers. Tridentate pseudocompound hooks are present in the first 3 setigers; one hook is clearly thicker than the others, but is otherwise similar. A single compound spiniger is present in each parapodium from setiger 4 through setiger 13. Subacicular hooks are first present from setiger 13. All specimens are white without color patterns.

Augener (1931:296) also reviewed the type-material of this species, but his description does not fit the material nor does it fit the original description by Kinberg (1865) or the illustrations published in Kinberg (1910). Both description and illustrations by Kinberg fit the type-material very well and have been augmented above. It is unclear how Augener's interpretation arose; it has apparently led to confusion as to the number of taxa present in Argentinian waters. Orensanz (1974), using Augener's study as his authority for the description of Kinberg's species, reported a number of species of *Onuphis* from Argentinian waters. The specimens called *O. fragilis* by Orensanz (1974:94) clearly do not belong to that species (see below); they resemble *O. intermedia*, but differ from this species as well in a number of features. According to Orensanz, his specimens have branchiae first present from setigers 10–21 as single filaments; the ventral cirri are cirriform on 3 or 4 setigers and the occipital ceratophores are smooth. Tridentate pseudocompound hooks are present in the first 3 setigers and a single, large hook is continued through one additional setiger. Compound spinigers are present from setigers 4 or 5 to setigers 13 or 15 and subacicular hooks are first present from setigers 14–16.

Orensanz's specimens and *O. intermedia* both belong to the same group of *Onuphis* in that both have branchiae starting behind setigers 10 and have compound spinigers present in a number of anterior setigers. They are listed separately in Table 2.

*Onuphis (Nothria) veleronis*, new name

Table 2

*Nothria stigmatis intermedia* Hartman, 1944:93–95, pl. 15, figs. 315–324; 1968:686–687, figs. 1–6. [Not *Onuphis intermedia* Kinberg, 1865].

*Material examined*.—Northwest Anchorage, San Clemente Island, California, 20 fms, 12 September 1933 (holotype, AHF Poly 744; 5 paratypes, AHF Poly 745).

*Remarks*.—The holotype is an incomplete specimen with about 60 setigers that is 19 mm long and about .5 mm wide; the largest paratype consists of 85 setigers and is 32 mm long. Ceratophores are smooth; branchiae are first present from setigers 29–30 and ventral cirri are cirriform on the first 3 setigers. Tridentate pseudocompound hooks are present in 3 setigers and compound spinigers are present in setigers 4–13. A single large hook is present from setiger 4 ending between setigers 6 and 8. The first subacicular hook is in setigers 10–14. A unique feature is the presence of subdistally expanded acicula from setiger 4 to about setiger 8.

*O. veleronis* differs clearly from *O. stigmatis* (see Table 2) in that the latter has the first branchiae on setigers 18–22, subacicular hooks from setigers 14–16 and a color pattern consisting of dark cross-bars. *O. veleronis* lacks a color pattern. *O. veleronis* differs clearly from *O. intermedia* Kinberg in setal distribution. Thus a new name was needed for this taxon.

*Etymology*.—The type-material was collected on one of the shakedown cruises of the VELERO III of the Allan Hancock Foundation, University of Southern California, hence the specific name.

Subgenus *Onuphis* Andouin and Milne Edwards, 1833

*Onuphis (Onuphis) fragilis* Kinberg, 1865

Table 6

*Onuphis fragilis* Kinberg, 1865:561; 1910:40, pl. 15, fig. 11.—Augener, 1931:298, fig. 6. [Not *O. fragilis*.-Orensanz, 1974:94–95, pl. 7].

*Material examined*.—Atlantic Ocean, South of La Plata (holotype, Riksmuséet, Stockholm, marked E.E. 307 and type number 465).

*Remarks*.—The type-material fits very well with Kinberg's description and illustrations. Occipital ceratophores are smooth; branchiae are first present from setiger 6 and are bifid in most segments. Ventral cirri are cirriform in the first 7 setigers. Tridentate pseudocompound hooks are present in the first 6 setigers and a single large hook continues to setiger 12. Subacicular hooks are first present from setiger 25 and compound spinigers are absent.

Augener (1931:298) redescribed the type-material, but his description does not fit the material, not does it fit with the original description. For example, Augener did not find branchiae before setiger 12; branchiae are clearly present from setiger 6 in the type-specimen. It is unclear what caused this lapsus; apparently it led Orensanz (1974) to refer material, discussed above under *O. intermedia*, to this species, to which it clearly does not belong.

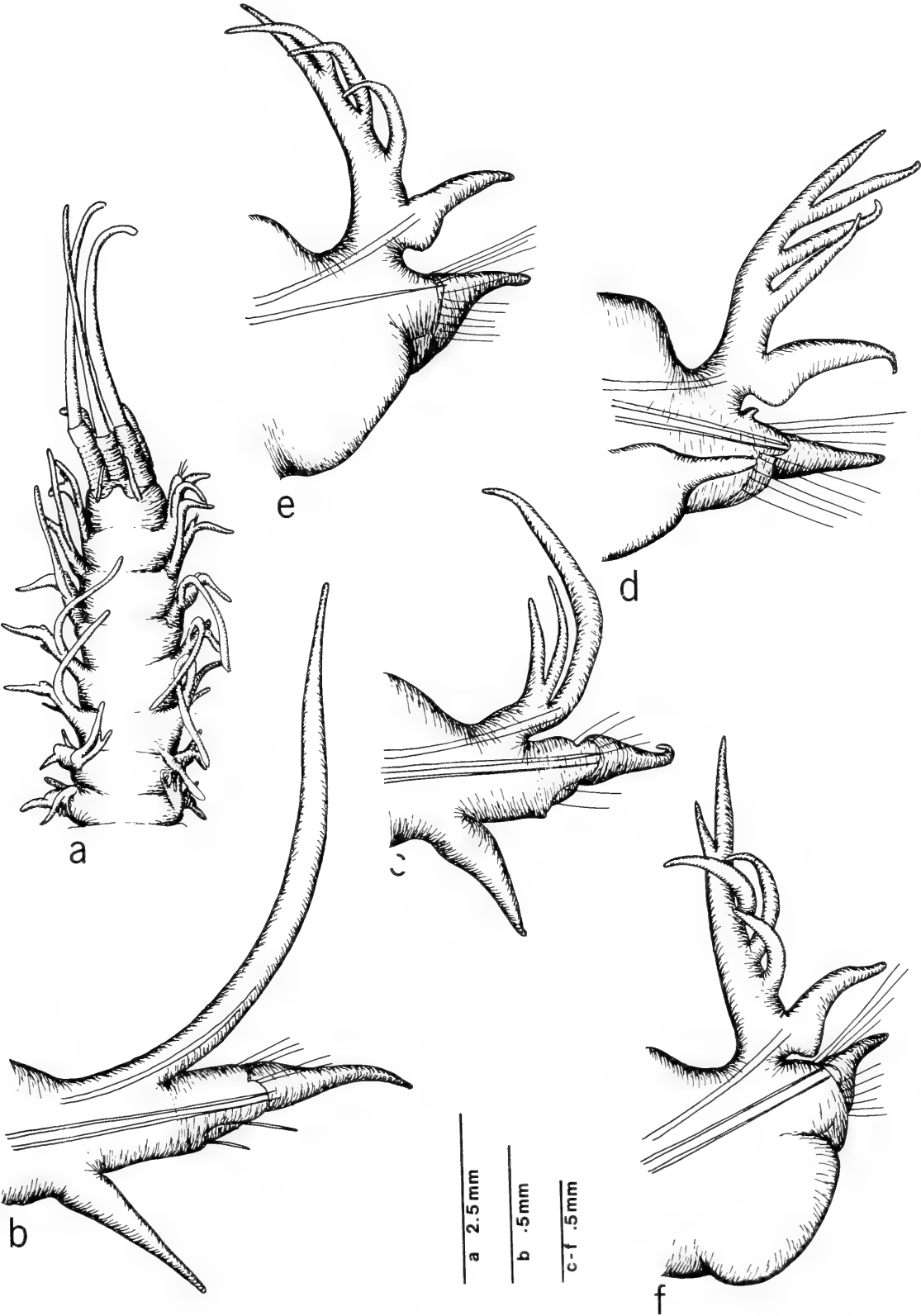


Fig. 3. *Onuphis (Onuphis) geminata* (holotype, USNM 61239): **a**, Anterior end, dorsal view; **b**, Parapodium from setiger 3, anterior view; **c**, Parapodium from setiger 6, anterior view; **d**, Parapodium from setiger 9, anterior view; **e**, Parapodium from setiger 12, anterior view; **f**, Parapodium from setiger 15, anterior view.

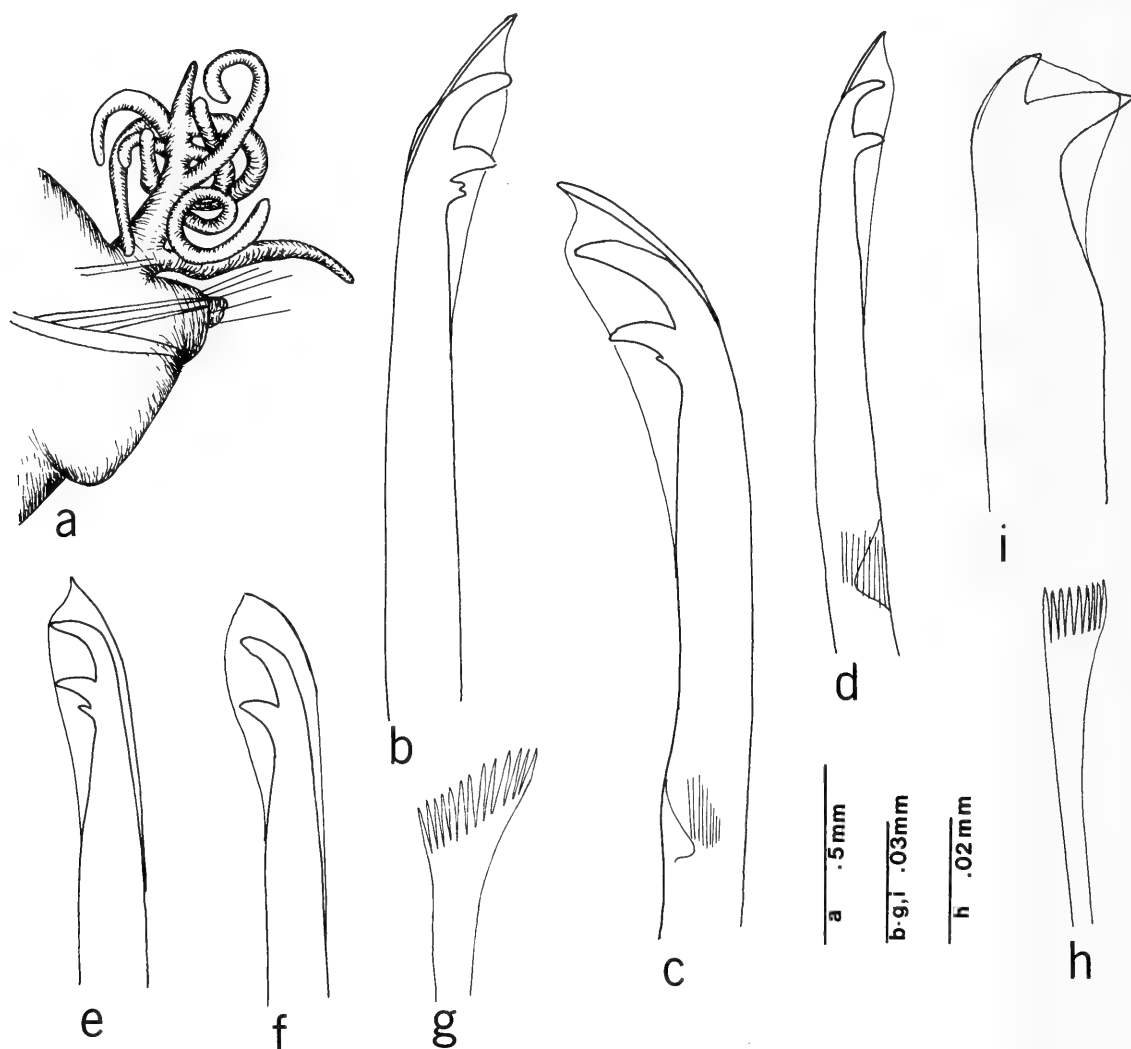


Fig. 4. *Onuphis (Onuphis) geminata* (holotype, USNM 61239): a, Parapodium from setiger 50, anterior view; b-f, Pseudocompound hooks; b, From setiger 3, upper hook; c, From setiger 3, median hook; d, From setiger 3, lowermost hook; e, From setiger 6, upper hook; f, From setiger 6, lowermost hook; g, Pectinate seta, setiger 50; h, Pectinate seta, setiger 3.

*Onuphis (Onuphis) geminata*, new species

Figs. 3-4, Table 4

*Material examined*.—CB-40A (holotype, USNM 61239, 2 paratypes, USNM 61240).

*Description*.—The holotype is an incomplete specimen that is 32 mm long for 81 setigers and 1.1 mm wide with parapodia. The anterior end is cylindrical and the posterior part of the fragment is dorsally flattened. All color patterns are dark brown except where specified. The frontal antennae are yellow; otherwise the prostomium is evenly light rose-colored. Most ceratophoral rings have narrow bands; the ceratostyles have speckled, irregular

markings. The peristomium has a band across the anterior edge on the dorsal side; setiger 1 lacks pigmentation, but from setiger 2 at least through setiger 50, each setiger has a narrow band across the dorsum at the anterior  $\frac{1}{3}$  of each segment. Setiger 3 has the most distinct of these bands, which become increasingly faint posteriorly; the band is broken up into 2 dorsolateral rows of patches for about 10 segments posterior to setiger 50. The whole ventrum, the parapodia and the remainder of the dorsum are evenly light rose- or flesh-colored and lack distinctive color patterns.

The prostomium (Fig. 3a) is a small, rounded lobe; the frontal antennae are nearly as long as the prostomium and spindle-shaped. The occipital antennae are disposed in a semicircle. The outer lateral ones reach setiger 2, with more than  $\frac{1}{2}$  their length in the ceratophore. The inner lateral and median occipital antennae reach setiger 6. Each ceratophore has 9–10 rings of which the distalmost one is about as wide as 3 of the other rings combined. The peristomium is about as long as the first setiger and carries a pair of slender peristomial cirri on its frontal margin.

The first parapodia are no larger than those of the next several setigers and similar in shape. Each (Fig. 3b) has a flattened, rather wide base. The acicular lobe is distally rounded; the superior half of the presetal lobe follows the acicular lobe closely; the inferior half projects beyond the acicular lobe as a rounded, flattened flap with a distinct excision on the inferior edge. The dorsal cirri in the first 5 setigers are extremely long and slender and at setiger 3 (Fig. 3b) are at least twice as long as the whole parapodium from the base to the tip of the acicular lobe. The postsetal lobes are about as long as the parapodial bases and are spindle-shaped. The ventral cirri are attached near the base of the parapodia; each tapers evenly to a fine point. The dorsal cirri rapidly decrease in length posteriorly (Figs. 3b–f, 4a) and develop distinct swellings near the base. At setiger 9 (Fig. 3d) each dorsal cirrus is about as long as the postsetal lobe and rather similar in shape. Ventral cirri are cirriform through the first 9 setigers and are pad-shaped thereafter. In setigers 8 and 9 the tip of the ventral cirrus is distinctly on the anterior face of the parapodia and the pads that replace the ventral cirri are placed on the anterior face of the parapodia (Figs. 3e–f). Postsetal lobes remain well developed in all parapodia present. A small, distinct cirrus is present on the superior edge of the parapodium near the base of the dorsal cirrus in setiger 9.

Limbate setae, pectinate setae, pseudocompound and subacicular hooks are present. Large hooks and compound spinigers are absent. Limbate setae are present in all setigers, but are especially numerous in setigers 8–25. Two different groups of pectinate setae are present. Setigers 2–6 have narrow, distally transverse setae with about 8 teeth (Fig. 4h). Pectinate setae are absent in setigers 7 through about setiger 18. From about setiger 18 another kind is present; each (Fig. 4g) is distally oblique and has about 12 teeth.

Pseudocompound hooks are present in the first 7 setigers. Most of the hooks (Fig. 4b, c, e) are tridentate with 2 distal teeth of about the same size and the third tooth reduced and closely appended to the second one. In a few hooks, the lower tooth appears bifid (Fig. 4b). In addition, a single bidentate hooks (Figs. 4d, f) with subequal teeth is present inferiorly in each fascicle. Subacicular hooks are first present in setiger 23; each (Fig. 4i) is bidentate.

Branchiae are first present from setiger 6 (Fig. 3e) and are bifurcated from the first. Maximum number of branchial filaments is 8 or 9. The filaments are arranged as a series of lateral filaments on a main branchial stem in all setigers (Figs. 3d–f, 4a), but in median and posterior setigers the branchial stem becomes increasingly short compared to the length of the lateral filaments. In addition the filaments tend to curl up, so the branchiae may appear superficially as tufted filaments rather than the pectinate arrangement actually present.

The jaws are well sclerotized; the maxillary formula is 1+1, 7+8, 6+0, 6+7 and 1+1 in one of the paratypes.

Only two of the three specimens could be examined in detail; the third specimen clearly belongs to the same species in terms of color pattern and the structure of the branchiae, but the anterior end is regenerating so no valid counts or measurements could be made.

Tubes are delicate with a thin, flimsy inner lining, sparsely covered with sand grains.

*Remarks.*—*O. geminata* is here compared (Table 4) to other species with branchiae first present from about setiger 6 and without simple hooks in anterior setigers.

*O. zebra* Berkeley and Berkeley (1939:337–338, figs. 9–10) differs from all other species in this group by having compound spinigers in anterior setigers and subacicular hooks are absent; the holotype consists of only 35 setigers (USNM 32898); hooks may be present in other members of the species.

*O. acapulcensis* Rioja (1944:139–143, figs. 1–11), *O. cedroensis* Fauchald (1968:31–34, pl. 8, figs. a–g), *O. multidentata* Hartmann-Schröder (1960:24–26, figs. 50–55), *O. nannognathus* Chamberlin (1919:270–274, pl. 43, figs. 8–11, pl. 44, figs. 1–5), *O. oligobranchiata* Orensanz (1974:93–94, pl. 6), *O. pourtalesii* (Ehlers, 1879:273, see also Ehlers, 1887:74–75, pl. 19, figs. 6–10, pl. 20, figs. 1–6), *O. proalopus* Chamberlin (1919:265–269, pl. 40, figs. 3–8, pl. 41, figs. 1–10), *O. profundus* Fauchald (1968:40–41, pl. 10), *O. similis* Fauchald (1968:28–29, pl. 4, figs. g–i), *O. lineata*, new name (for *O. striata* Hartmann-Schröder, 1965:164–167, figs. 135–137, see below) and *O. tenuis* Hansen (1882:10, pl. 3, figs. 15–22, see also Orensanz, 1974:87–89, pl. 3) all have exclusively tridentate pseudocompound hooks; other species in this group have both bi- and tridentate hooks. Of these, *O. dorsalis* (Ehlers, 1897:71–74, pl. 5, figs. 108–118, see also Hartmann-Schröder, 1962:114–117, figs. 115–119) and *O. heterouncinata* (Hartmann-Schröder, 1965:161–164,

figs. 132–134) have subacicular hooks first present on setigers 14 and 12 respectively. *O. dorsalis* has 3 branchial filaments and *O. heterouncinata* a single filament per segment (thus, by definition, a member of the subgenus *Nothria*, but with so great similarities to species of the subgenus *Onuphis* that it is considered here for the sake of completeness). *O. geminata* and *O. investigatoris* Fauvel (1932:147–148, pl. 6, figs. 1–6, textfig. 21), the two remaining species in the group, have at least 8 branchial filaments where the branchiae are best developed. *O. geminata* has subacicular hooks starting at setigers 23; the start of the subacicular hooks is not stated in Fauvel (1932), but judging from his Plate 6, figs. 4 and 5, they must start posterior to setiger 10 and anterior to setiger 30. It is here assumed that *O. geminata* cannot be separated from *O. investigatoris* on this character. The two species can be separated on the structure of the occipital antennae. The inner lateral occipital antennae are at least twice as long as the median one in *O. investigatoris* and reach setiger 15; in *O. geminata* these 3 antennae are of about the same length and reach setiger 6. There are also minor differences in the distribution of cirriform ventral cirri, pseudocompound hooks and in the number of branchial filaments as indicated in Table 4. Additionally, *O. geminata* is oculate, *O. investigatoris* is not.

*O. geminata* is known from a single locality in *Thalassia* and fine sand in a mangrove area about 10 km north of the city of Dangriga, Belize.

*Etymology*.—The specific name, Latin for twinned, refers to the close similarity between this and other species of the genus in Belize.

#### *Onuphis (Onuphis) lineata*, new name

##### Table 4

*Onuphis striata* Hartmann-Schröder, 1965:164–167, figs. 135–137.

*Material examined*.—Off Chile (holotype, Hamburg Staatsmuseum, P-14293).

*Remarks*.—The specimen is as described by Hartmann-Schröder (1965). Pseudocompound hooks are present in the first 7 setigers and postsetal lobes are distinct in the first 50 setigers. Branchiae are present from setiger 6 at least through setiger 99; an additional 30 setigers are present in the type, but are in recent regeneration and lack branchiae.

The name *O. striata* is preoccupied in the combination *O. striata* Ushakov (1950), originally described as *Onuphis parva striata* Ushakov, (1950:193, fig. 25, see also Ushakov, 1955:235–236, fig. 74B and 77J). Fauchald (1968:37) elevated Ushakov's subspecies to separate specific status. Hartmann-Schröder (in litt.) requested that a new name be given her taxon from Chile.

*O. lineata* is known from the type-locality only.

*Etymology*.—The specific name, Latin meaning (in part) striped, was se-



lected to parallel as closely as possible the meaning of the name initially used for this taxon; both names refer to the presence of numerous narrow transverse bands of dark brown pigment across the dorsum in anterior setigers.

*Onuphis (Onuphis) pulchra*, new species

Figs. 5–6, Tables 5, 6

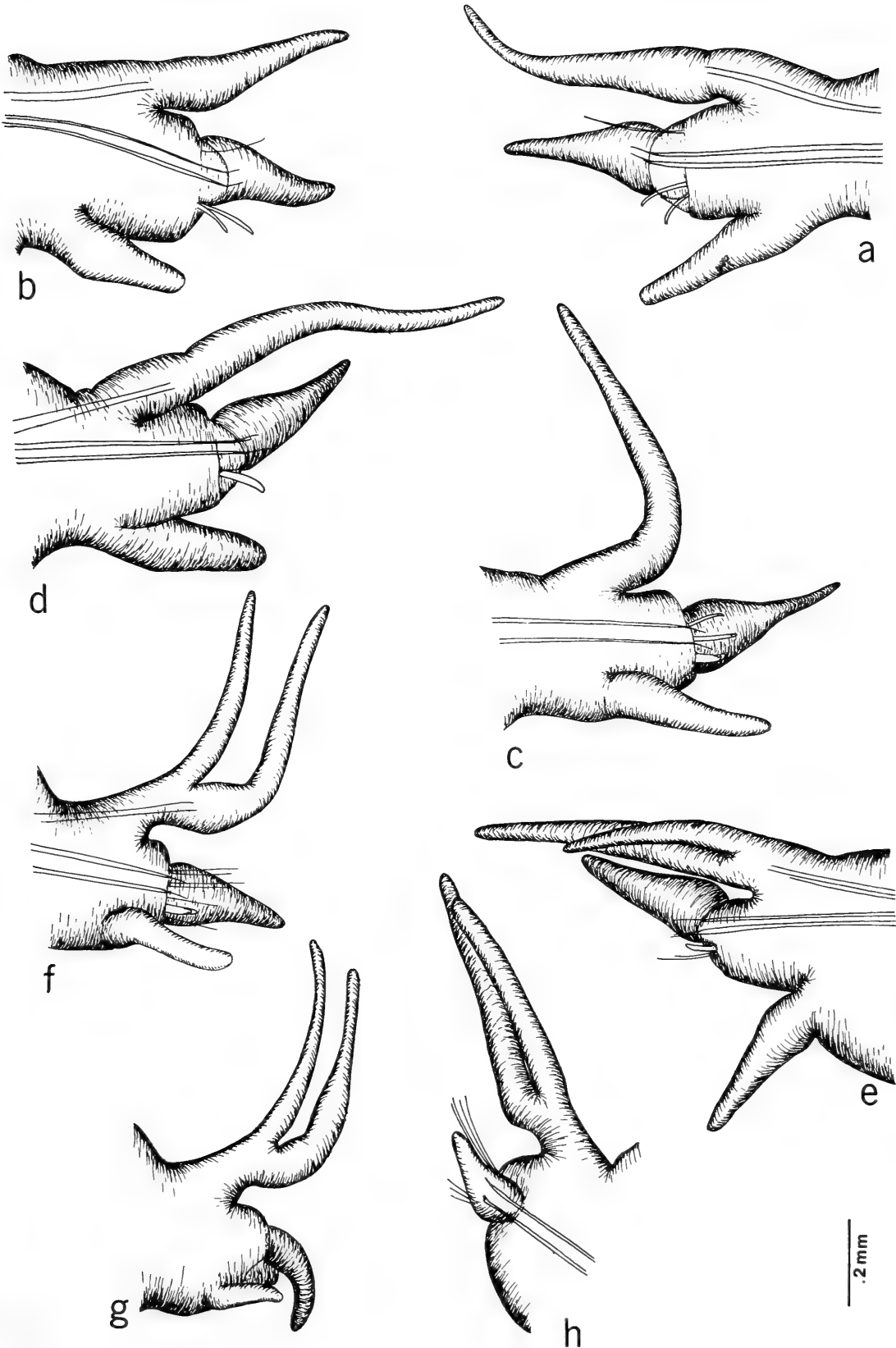
*Material examined*.—CB-1 (holotype, USNM 61241; 58 paratypes, USNM 61242); CB-16 (45); F-19 (13); F-21 (3); F-28 (7); F-33 (1).

*Description*.—The holotype is a complete specimen with 240 setigers that is 70 mm long and 1.3 mm wide including parapodia. The anterior part of the body, including the 5 first setigers is cylindrical. Posterior to setiger 6 the body becomes increasingly flattened dorsally and the ventrum convexly curved, creating a space above the animal in the tube. The complex color pattern consists of dark brown pigment rings and patches. The prostomium and peristomial rings lack color patterns. Each of the outer lateral ceratostyles has a narrow ring near the base; the remaining occipital antennae lack color patterns. There is a broad band across the posterior half of the first setiger, darkening distinctly towards the intersegmental groove to the second setiger. The anterior half of the first setiger appears translucently white (due to the presence of a field of epidermal glands). Each setiger back to about setiger 30 has a transverse band at the posterior edge. These bands become reduced medially at about setiger 30 and become interrupted into two rows of dorsolateral transverse patches at about setiger 30. These two rows are continued posteriorly for about 10 more setigers. Each dark band is bordered anteriorly by a narrow translucent band of epidermal glands; these bands disappear at about setiger 30. The ventrum and the rest of the body are evenly light rose-colored in alcohol and lack distinct color pattern. The color pattern is as described also in live specimens.

The prostomium (Fig. 6a) is nearly circular and has a pair of short, triangular frontal antennae. The outer lateral occipital antennae barely reach the posterior edge of the peristomium; in most individuals they are curved anteroventrally. Each has a spindle-shaped style and a short ceratophore with 4 rings. The inner lateral occipital antennae reach setiger 4–5; the median one reaches setigers 3–5 in most specimens (see Table 5); each has

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Fig. 5. *Onuphis (Onuphis) pulchra* (holotype, USNM 61241); a, Parapodium from setiger 1, anterior view; b, Parapodium from setiger 2, anterior view; c, Parapodium from setiger 4, anterior view; d, Parapodium from setiger 5, anterior view; e, Parapodium from setiger 6, anterior view; f, Parapodium from setiger 7, anterior view; g, Parapodium from setiger 8, anterior view; h, Parapodium from setiger 12, posterior view.



a short ceratophore with 4 to 5 rings of which the distalmost one makes up about one-half of the length of the ceratophore. The peristomial cirri are attached at the anterior edge of the peristomial rings; each is spindle-shaped and reaches just beyond the bases of the occipital antennae. A pair of black eyespots are present between the bases of the outer and inner lateral occipital antennae.

The first few parapodia (Fig. 5a) are attached laterally. The first projects anteriorly; each ramus is about as long as the body is wide. The presetal lobe has a rounded distal edge with a distinct excision on the ventral side. A contraction fold can be present across the parapodium at the base of the presetal lobe. The acicular lobe is rounded. The postsetal lobe is about as long as the base of the parapodium and is spindle-shaped. The dorsal cirrus is distinctly longer than the postsetal lobe and reaches well beyond all other parapodial parts and is spindle-shaped. The ventral cirrus is digitate and reaches the tip of the acicular lobe. The second and third parapodia (Fig. 5b) are similar in shape, except that the parapodial bases are shorter and relatively wider than that of the first parapodium. In the fourth and fifth parapodium (Figs. 5c–d) the acicular lobes become increasingly wider and distally more truncate than that of the first one. The presetal lobes are flattened to follow the outline of the acicular lobe closely. The dorsal cirri are longer compared to the other parapodial parts and the ventral cirri become shorter and are placed on the anterior face of each parapodium. The ventral cirri are cirriform through setigers 9–10 (Figs. 5e–g, Table 5). Dorsal cirri are present in all setigers to the posterior end; they become increasingly slender posteriorly but are of about the same length as those in the anterior setigers. Postsetal lobes (Fig. 5h) can be recognized in the first 50 setigers as a distinct digitiform lobe on the distal end of a low, rounded fold that closely follows the outline of the acicular lobe.

Branchiae are first present from setiger 6 (Table 5); the first 10 setigers have a single branchial filament; thereafter, the numbers increase to 3 or 4; the branchiae again become single filaments at about setigers 70–100 (approximately  $\frac{1}{2}$  the length of the specimen) and the last  $\frac{1}{5}$  of the length of each specimen lacks branchiae.

Limbate and pectinate setae, two kinds of anterior hooks and subacicular hooks are present. Limbate setae are most common in the first 50 setigers. Pseudocompound tridentate hooks (Fig. 6b–h) are present in the first 6 setigers. Each has a blunt hood and the teeth are curved and slender, decreasing more or less evenly in size from the distal to the proximal tooth. Large tridentate hooks (Fig. 6k–n) are present from setiger 4 to the last segment before the start of the subacicular hooks. Each large hook is at least twice as heavy as the pseudocompound hooks of the same segment; the median tooth is larger than the distal one in all large hooks. The median tooth becomes increasingly curved and the distal tooth more erect posteriorly

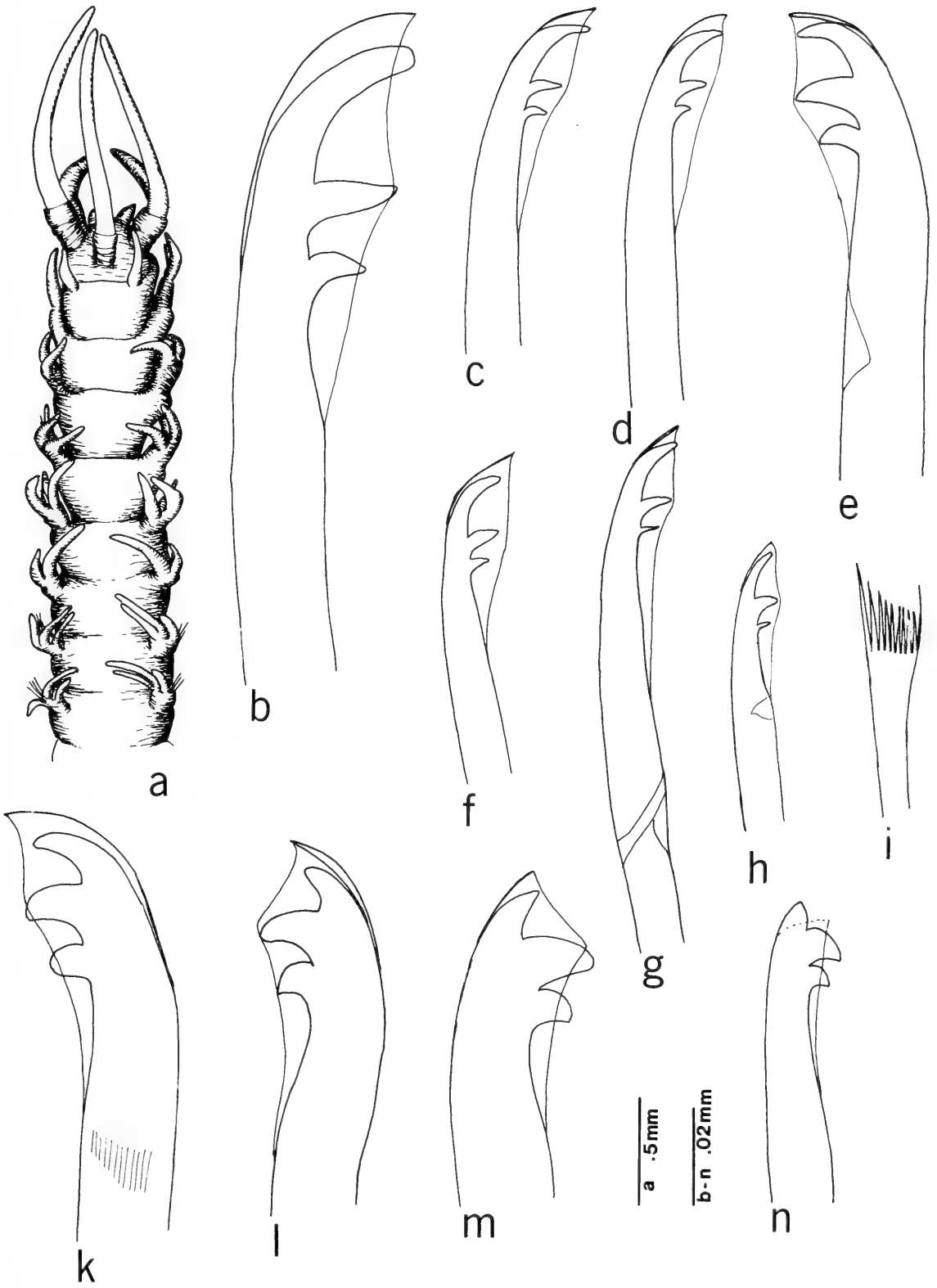


Fig. 6. *Onuphis* (*Onuphis*) *pulchra* (holotype, USNM 61241): **a**, Anterior end, dorsal view, **b-h**, Pseudocompound hooks; **b**, From setiger 1; **c**, From setiger 2; **d-e**, From setiger 3; **f**, From setiger 4; **g**, From setiger 5; **h**, From setiger 6; **i**, Pectinate seta, from setiger 3; **k-n**, Large hooks; **k**, From setiger 4; **l**, From setiger 5; **m**, From setiger 6; **n**, From setiger 12.

(Fig. 6n). Bidentate subacicular hooks are present from setigers 16–20 (Table 5); usually 2 hooks are present in a segment. Pectinate setae (Fig. 6i) are present from the second setiger; each is slightly oblique distally and has about 12 teeth.

The maxillary formula is 1+1, 6–7+8, 8+0, 5-6+8 and 1+1 as observed by dissection of four paratypes. The whole jaw-apparatus is poorly sclerotized and soft.

The tubes have a tough, translucent inner lining and are densely and evenly covered with shell-fragments and coral debris.

*Remarks.*—The relations between *O. pulchra*, *O. virgata* (see below) and related taxa can best be clarified by discussing them jointly. Table 6 surveys species of *Onuphis* with branchiae first present from about setiger 6 and with large tridentate hooks in some anterior setigers, in addition to the pseudocompound hooks present in all species of the genus.

*O. fragilis* Kinberg (1865:561, see also Kinberg, 1910:40, pl. 15, fig. 11 and above) has smooth occipital ceratophores; all other species have distinctly ringed ceratophores. Three species, *O. jenneri* Gardiner (1976:192–193, fig. 24o–t), *O. microcephala* Hartman (1944a:78–80, pl. 3, figs. 67–75, pl. 18, fig. 339, see also Gardiner, 1976:191–192, fig. 24k–n) and *O. pigmentata* Fauchald (1968:38–39, pl. 9, figs. f–n) have pad-shaped ventral cirri from setiger 3; the other species have cirriform ventral cirri through at least setiger 4. *O. taeniata* Paxton (1979:284–288, figs. 43–55) and *O. vermillionensis* Fauchald (1968:41–43, pl. 11) have large hooks through setiger 10, the remaining three species, *O. setosa* Kinberg (1865:560, see also Kinberg, 1910:40, pl. 14, fig. 10 and Orensanz, 1974:89–93, pls. 4–5) and the two new species have large hooks at least through setiger 13.

It is difficult to define *O. setosa* precisely in relation to the two new species. It differs from *O. pulchra* in that it has fewer segments with cirriform ventral cirri and fewer segments with pseudocompound hooks. Orensanz (1974:89–93) indicated the range of variation of these features he found in *O. setosa*, but one cannot determine from Orensanz's description how this variability is distributed. The two species differ clearly in color patterns in that *O. setosa* has dark pigment bands on both pro- and peristomium according to Orensanz (1974:89, pl. 4, fig. 1); all specimens of *O. pulchra* lack pigment on both pro- and peristomium. *O. setosa* differs from *O. virgata* in that it has 4 to 8 setigers with cirriform ventral cirri and 4 to 5 setigers with pseudocompound hooks; *O. virgata* has 11–13 setigers with cirriform ventral cirri and 7 setigers with pseudocompound hooks. *O. pulchra* has pseudocompound hooks in 6 setigers and cirriform ventral cirri in 9 to 10 setigers. *O. virgata* has color patches and bands on the pro- and peristomium; *O. pulchra* lacks such color patterns. The numerical differences appear minor, but are statistically different (chi squared, at the .01 level,

even if the sample of *O. virgata* is too small for strict application of any statistical tests).

*O. pulchra* is very common in *Thalassia*-flats in shallow water near Carrie Bow Caye, Belize.

*Etymology*.—The specific name, Latin meaning pretty or beautiful, refers to the striking color pattern of the anterior end.

*Onuphis (Onuphis) virgata*, new species

Fig. 7, Tables 6, 7

*Material examined*.—CB-40A (1 specimen); CB-40B (holotype, USNM 61248, 3 paratypes, USNM 61249).

*Description*.—The holotype is an incomplete specimen with 149 setigers that is 57 mm long and .7 mm wide with parapodia. The anterior end, including the 5 first setigers, is cylindrical, median and posterior parts of the body are dorsally flattened and the parapodia become increasingly dorso-lateral in position. A distinct color pattern of dark brown bands and patches is present on the anterior end of the body. A narrow band is at the base of all ceratostyles and a large dark patch is on the prostomium in front of the occipital antennae. The peristomium has a wide band across the dorsum and the first setiger is evenly light brown with a darker band across the posterior half on the dorsal side only. The next dozen or so segments have dark bands across both dorsum and ventrum. The pigment bands on the ventrum rapidly fade posteriorly and are absent after setiger 20. The dorsal pigment bands break up into dorsolateral patches which continue to about setiger 50. Each of the first 5 or 6 pairs of parapodia has a dark patch near the distal end of the acicular lobe on the posterior face. The rest of the body is pale pink-colored.

The prostomium (Fig. 7f) is frontally rounded and has the occipital antennae attached in a semicircle; the frontal antennae are narrowly triangular. The outer lateral occipital antennae barely reach the posterior edge of the peristomial rings. The inner lateral and median occipital antennae reach about the middle of setiger 3; each ceratophore has about 4 rings of which the distalmost is longer than the 3 others combined. The peristomial rings are about half as long as the first setiger; the anteriormost carries a pair of short, slender peristomial cirri on the frontal edge.

The first parapodia are directed forward and ventrally; they are of about the same size as those of the second and third setiger. Each (Fig. 7a) has a wide, antero-posteriorly flattened base; there may be a contraction fold across the anterior face of each parapodium at the level of the bases of the dorsal and ventral cirri (not shown in the illustration). The presetal lobe is obliquely rounded and is distinctly excised on the ventral side. The acicular

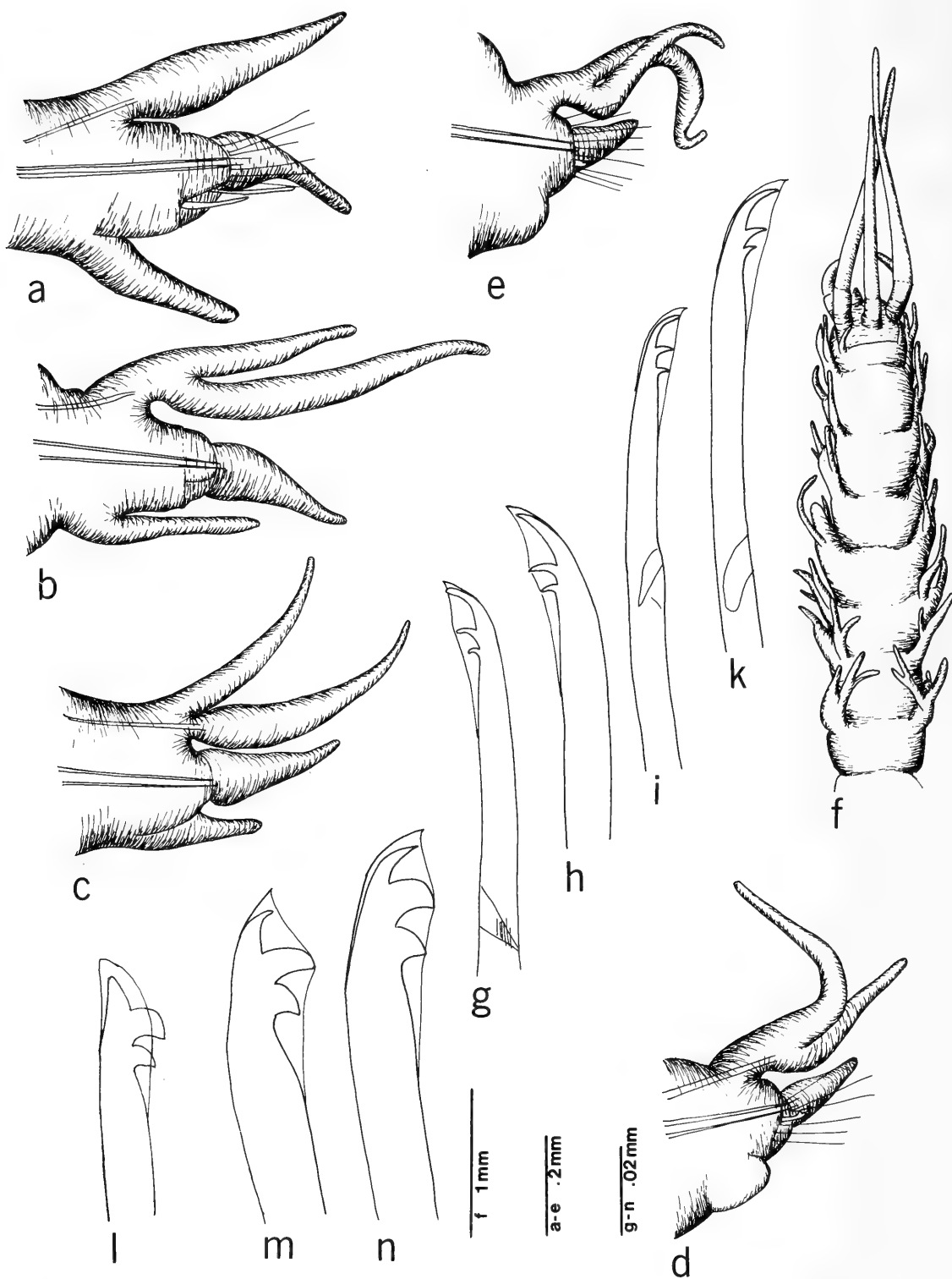


Fig. 7. *Onuphis (Onuphis) virgata* (holotype, USNM 61248): a, Parapodium from setiger 3, anterior view; b, Parapodium from setiger 6, anterior view; c, Parapodium from setiger 9, anterior view; d, Parapodium from setiger 15, anterior view; e, Parapodium from setiger 18, anterior view; f, Anterior end, dorsal view; g-k, Pseudocompound hooks, g, From setiger 3; h, From setiger 6; i-k, From setiger 7 of a paratype; l-n, Large hooks, l, From setiger 12; m, From setiger 6; n, From setiger 7 of a paratype.

lobe is evenly rounded. The postsetal lobe is spindle-shaped and is about as long as the base of the parapodium. The dorsal cirrus is digitate; it is shorter than the postsetal lobe. The ventral cirri remain cirriform through about 12 setigers (see Tables 6 and 7); they decrease in size from the first setiger (Fig. 7a–e) and move on to the anterior face of each parapodium from about setiger 9. The postsetal lobes remain distinct in all segments in the fragments available (of which the holotype is the longest), but decrease rapidly in size at about setigers 20–25; they are short, digitate extensions from the middle of a wide, rounded lobe in all posterior setigers. The dorsal cirri become somewhat more slender in posterior setigers, but remain about the same length.

Branchiae are first present from setigers 6–7 (Table 7); the first branchia is a single filament, more posteriorly the branchial filaments increase to about 5. The number of filaments decrease in more posterior segments; in all specimens examined the branchiae have at least 2 filaments, even on the last setigers present.

Limbate and pectinate setae, pseudocompound, large and subacicular hooks are present. Limbate setae are present in most setigers, but are densest in anterior setigers; pectinate setae are present from about the third setiger; each has a transverse distal margin with about 8 teeth. Pseudocompound hooks (Figs. 7g–k, Table 7) are present in the first 7 setigers. Each is slender and has 3 slender teeth; the hooks are short and distally blunt. The teeth decrease rather evenly in size from the distalmost one. Large hooks (Figs. 7l–n) are present from setiger 4 through about setiger 21; each is at least twice as thick as the pseudocompound hooks of the same segment, and tridentate; the distal tooth is short and slender and is erect in at least the last 10 segments. Bidentate subacicular hooks are present from about setiger 22. There are no segments with both large and subacicular hooks. Compound spinigers are absent.

The maxillary formula is 1+1, 7+9, 7+0, 5+9 and 1+1 as examined in one paratype. The jaw-apparatus is well sclerotized. The teeth on left maxilla IV are unusually long and slender.

The tubes have a thin inner lining and are covered with fine sand-grains.

The relationships between *O. virgata* and similar species have been discussed above.

*O. virgata* is known from an area about 10 km North of the city of Dangriga, Belize, in *Thalassia* and fine sand in mangroves.

*Etymology*.—The specific name, Latin meaning (in part) colored stripes, refers to the striking color pattern of this species.

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Table 1.—Onuphidae (Polychaeta) previously reported from the Gulf of Mexico and Caribbean Sea. Some species (e.g. *Diopatra cuprea*) have been reported frequently from the U.S. Gulf coast; no attempts were made to include those records in the table.

Name	Record	Local depth distribution
<i>Americonuphis magna</i> (Andrews, 1891)	Treadwell, 1921 Hartman, 1951 Suarez and Fraga, 1978	Intertidal-shallow subtidal
<i>Diopatra cuprea</i> (Bosc, 1802)	Augener, 1906 Monro, 1933 Hartman, 1951 Fauchald, 1977 Suarez and Fraga, 1978	Intertidal to about 200 m
<i>Hyalinoecia bilineata</i> Baird, 1870	Rullier, 1974	Shallow subtidal
<i>H. branchiata</i> Treadwell, 1934	Treadwell, 1934 Treadwell, 1939 Suarez and Fraga, 1978	Deeper than 200 m
<i>H. juvenalis</i> Moore, 1911	Hartman, 1944b Kiseleva, 1968 Suarez and Fraga, 1978	Shallow subtidal

Table 1.—Continued.

Name	Record	Local depth distribution
<i>H. tubicola</i> (O. F. Müller, 1776)	Augener, 1906 Hartman, 1942 Hartman, 1951 Suarez and Fraga, 1978	Deeper than 200 m
<i>H. varians</i> Baird, 1870	Baird, 1870 Ehlers, 1887 Kiseleva, 1968 Suarez and Fraga, 1978	Shallow subtidal
<i>Onuphis</i> ( <i>Nothria</i> ) <i>conchylega</i> Sars, 1835	Augener, 1906 Kiseleva, 1968 Suarez and Fraga, 1978	Deeper than 200 m
<i>O. (N.) opalina</i> Verrill, 1873	Augener, 1906 Kiseleva, 1968 Suarez and Fraga, 1978	Deeper than 200 m
<i>O. (N.) rubrescens</i> Augener, 1906	Augener, 1906 Suarez and Fraga, 1978	Deeper than 200 m
<i>O. (N.) sombreriana</i> (McIntosh, 1885)	McIntosh, 1885 Suarez and Fraga, 1978	Deeper than 200 m
<i>Onuphis</i> ( <i>Onuphis</i> ) <i>eremita</i> Audouin and Milne Edwards, 1833	Kiseleva, 1968 Rullier, 1974 Suarez and Fraga, 1978	Shallow subtidal
<i>O. (O.) eremita oculata</i> Hartman, 1951	Hartman, 1951	Shallow subtidal
<i>O. (O.) pourtalesii</i> (Ehlers, 1879)	Ehlers, 1879 Ehlers, 1887 Augener, 1906 Hartman, 1938 Suarez and Fraga, 1978	Deeper than 200 m
<i>O. (O.) vermillionensis</i> Fauchald, 1968	Fauchald, 1977	Shallow subtidal
<i>Paradiopatra fragosa</i> Ehlers, 1887	Ehlers, 1887 Hartman, 1938	Deeper than 200 m
<i>P. glutinatrix</i> Ehlers, 1887	Ehlers, 1887 Augener, 1906 Hartman, 1938	Deeper than 200 m
<i>Paronuphis gracilis</i> Ehlers, 1887	Ehlers, 1887 Hartman, 1938	Deeper than 200 m
<i>Rhamphobrachium agassizii</i> Ehlers, 1887	Ehlers, 1887 Hartman, 1938 Treadwell, 1939 Kiseleva, 1968 Suarez and Fraga, 1978	Deeper than 200 m

Table 2.—Species of *Onuphis* (*Nothria*) with branchiae first present on or after setiger 10. \*See comment in text, p. 807.

Name	# of rings ceratophores	Branchiae from setiger #	# of cirriform ventral cirri	# of setigers with pseudocomp. hooks	# of teeth in pseudocomp. hooks	# of setigers with large hooks	# of setigers with comp. spinigers	Subacicular hooks from setiger #	Color pattern
<i>cirrata</i>	6	17-18	6	5	3	—	8-12	13	dark bars
<i>dangrigae</i>	4-5	18-21	4-5	5	2 or 3	—	6-14	14-16	none
<i>guadalupensis</i>	none	22	3	3	2 or 3	—	4-11	12	dark bars
<i>intermedia</i>	4-5	25	5	3	3	—	4-13	14	?
<i>rubrescens</i>	7-9	14-18	5	?5	3	?	absent	?	solid dark
<i>stigmatis</i>	4	18-22	3	3-4	3	5	4-13	14-16	dark bars
<i>veleronis</i>	none	29-30	3	3	3	11	4-11	12	none
Orensanz's specimens*	none	10-21	3-4	3	3	4	4 or 5-13 or 15	14-16	dark bars

Table 3.—Comparison of distribution of certain variable features of *Onuphis* (*Nothria*) *dangrigae* and *O. (N.) stigmatis*. The numbers represent the means  $\pm$  one standard deviation.

	Numbers examined	Branchiae from setiger #	Number of ventral cirri	# of setigers with pseudocomp. hooks	Subacicular hooks from setiger #
<i>dangrigae</i>	28	$20.43 \pm 1.93$	5 (inv.)	$4.54 \pm .51$	$15.14 \pm .76$
<i>stigmatis</i>	24	$19.42 \pm 2.10$	$3.50 \pm .51$	3 (inv.)	$14.46 \pm .78$

Table 4.—Species of *Onuphis* (*Onuphis*) with first branchiae from about setiger 6 and without simple (large) anterior hooks.

Name	Occipital antennae			% of cirriform ventral cirri	Max. # of branchial fil.	Pseudocompound hooks		Subacicular hooks from setiger #	# of teeth in pectinate setae	Remarks
	Length of:		# of rings			present to setiger #	# of teeth			
	i.l.	m.								
<i>acapulcensis</i>	4	4	12-15	5	12	?	3	15-18	15-20	—
<i>cedroensis</i>	4	5	3-4	4	5-6	3	3	14	9-10	Type examined
<i>dorsalis</i>	4	4	4	6	3	5	1 or 3	18	13	Sensu Hartmann-Schröder (1962)
<i>geminata</i>	6	6	9-10	9	8-9	7	2-3	23	12	New species
<i>heterouncinata</i>	3	4	?	4	1	4	2-3	12	?	—
<i>investigatoris</i>	15	7	?	6-7	10	5-6	2-3	?	?	Br. from 5-6
<i>lineata</i>	5	5	4-5	6	7	7	3	15	8	New name
<i>multidentata</i>	3	1	irreg.	2-3	10	3	3	9	10-14	—
<i>nannognathus</i>	16	16	5-8	7	8	6	3	21	14	Br. from 5, type examined
<i>oligobranchiata</i>	2	3	0	3-4	1	3	3	10-15	14	Br. on few set.
<i>pourtalesii</i>	10	12	10	3	8	?	3	?	20	Br. from 7-9
<i>proalopus</i>	17-18	4	6-7	7	6	5	3	21	15	Type examined
<i>profundi</i>	10	10	5-7	7	4	3	3	20	10	Br. from 7, type examined
<i>similis</i>	7	7	7-10	6	1	4	3	8	10	Type examined
<i>tenuis</i>	?	?	6-7	5-6	4	5	3	14	14	Orensanz (1974)
<i>zebra</i>	8	5	10-15	10	8	5	3	—	12	Compound spinigers present Type examined

Table 5.—Summary statistics on numerical features, *Onuphis (O.) pulchra*.

	Range	Mean	Stand. dev.	Number of observ.
Occipital antennae				
length of inner lateral	4–7	4.87	.58	38
length of median	3–6	4.26	.79	38
number of rings	5	invariant		
Branchiae				
start	5–7	5.98	.20	104
max. # filaments	2–5	3.32	.57	38
Cirriform ventral cirri	9–10	9.12	.56	104
Pseudocompound hooks to setiger #	6	invariant		
Simple hooks				
start	4	invariant		
end	15–19	16.16	1.37	38
Subacicular hooks from setiger #	16–20	17.34	.97	104

Table 6.— →

Table 7.—Summary statistics on variable features, *Onuphis (O.) virgata*.

	Range	Mean	Stand. dev.	Number of observ.
Occipital antennae				
length of inner lateral	3–5	3.60	.89	5
length of median	3–4	3.40	.55	5
number of rings	4–5	4.20	.45	5
Branchiae				
start	6–7	6.20	.45	5
max. # filaments	3–5	4.40	.89	5
Cirriform ventral cirri	11–13	12.20	.84	5
Pseudocompound hooks to setiger #	7	invariant		5
Simple hooks				
start	4	invariant		5
end	21–22	21.60	.55	5
Subacicular hooks from setiger #	22–23	22.60	.55	5

Table 6.—Species of *Onuphis* (*Onuphis*) with first branchiae at about setiger 6 and simple (large) hooks in some anterior setigers.

Name	Occipital antennae			# of cirriform ventral cirri	Max. # of branchial fil.	Pseudocompound hooks		# of setigers with large hooks	Subacicular hooks from setiger #	# of teeth in pectinate setae	Remarks
	Length of:		# of rings			present to setiger #	# of teeth				
	i.l.	m.									
<i>fragilis</i>	?	?	0	7	2	6	3	12	25	?	Type exam.
<i>jenneri</i>	3	2	4-5	2	6	4-5	3	30-35	30-35	15	Type exam.
<i>microcephala</i>	8	8	4-5	2	6-7	3	3	25	26	10	Gardiner (1976)
<i>pigmentata</i>	4	2	3-4	2	6-7	3	2-3	24	25	12-14	First br. on 7
<i>pulchra</i>	4-7	3-6	5	9-10	2-5	6	3	15-19	16-20	12	New species
<i>setosa</i>	?	?	4-6	4-8	6-7	4-5	2 or 3	13 or 17	12-21	8-10	Orensanz (1974)
<i>taeniata</i>	15	11	5-10	8-9	3-4	7	2-3	10	37-41	10-12	
<i>vermillionensis</i>	3	3	4-5	9	3-4	8	3	10	12	12-13	Type exam.
<i>virgata</i>	3-5	3-4	4-5	11-13	3-5	7	3	21-22	22-23	8	New species



## THE INDO-PACIFIC PIPEFISH GENUS *UROCAMPUS* (SYNGNATHIDAE)

C. E. Dawson

*Abstract.*—The genus *Urocampus* Günther is rediagnosed and compared with other genera with confluent superior trunk and tail ridges. Recognized species (*U. nanus* Günther, *U. carinirostris* Castelnau) are redescribed and illustrated and notes are provided on variation, distribution, and pouch larvae. The little known *Urocampus southwelli* Duncker is provisionally referred to the genus *Siokunichthys* Herald.

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This report, a continuation of revisionary studies on pipefishes, treats the genus *Urocampus* Günther which is in part characterized by the presence of confluent superior trunk and tail ridges. This feature is shared with a wide variety of temperate-tropical genera and some of these have been reviewed recently by Dawson (1976, 1977a, 1977b, 1979) and Dawson and Allen (1978). The two recognized species of *Urocampus* (*nanus*, *carinirostris*) are poorly known and existing descriptions are largely inaccurate or incomplete. Present study material is limited but the type material has been examined and males and females of each species have been illustrated.

Measurements are in millimeters (mm); proportional data are referred to standard length (SL) or head length (HL); total length (TL) measurements are given for pouch larvae; color descriptions are from specimens preserved in alcohol; depths are in meters (m); other methods follow Dawson (1977b). Abbreviations for repositories of materials examined follow: AMS—Australian Museum, Sydney; BMNH—British Museum (Natural History); CAS—California Academy of Sciences; CAS-SU—former Stanford University specimens housed as CAS; FMNH—Field Museum of Natural History; GCRL—Gulf Coast Research Laboratory Museum; MNHN—Muséum National d'Histoire Naturelle, Paris; NMV—National Museum of Victoria, Melbourne; QM—Queensland Museum, Brisbane; QVM—Queen Victoria Museum, Launceston, Tasmania; SAM—South Australian Museum, Adelaide; UMMZ—University of Michigan Museum of Zoology; USNM—National Museum of Natural History, Smithsonian Institution; WAM—Western Australian Museum, Perth; YCMP—Yokosuka City Museum.

### *Urocampus* Günther

*Urocampus* Günther, 1870:179 (orig. descr.; type-species *U. nanus* Günther 1870, by monotypy).

*Diagnosis.*—Superior trunk and tail ridges confluent, superior ridges not arched dorsad below dorsal-fin base, inferior trunk and tail ridges discontinuous near anal ring, lateral trunk ridge confluent with inferior tail ridge. Median dorsal snout ridge distinct, entire, usually elevated in adult males, not confluent with supraorbital ridges, usually fails to reach interorbital; supraorbital ridges elevated slightly with interorbital depressed between; supraopercular ridges absent; median dorsal head ridges low; median longitudinal opercular ridge essentially straight, usually crosses half or more of opercle in subadults and adults and margined with fine striae above and below; pectoral-fin base not protruding strongly laterad, without prominent ridges. Principal body ridges distinct, not elevated strongly, the margins entire, indented but not deeply notched between rings; scutella small, without longitudinal keels or other ornamentation; dorsum of body flat to somewhat concave anteriad, becoming convex toward dorsal-fin insertion, angled clearly upward about dorsal-fin base, becoming gradually flattened caudad; venter of trunk V-shaped, usually with a median keel-like ridge in adults; venter of tail essentially flat; posterior tail rings usually shortened progressively toward caudal-fin base. Without spines or prominent denticulations; subadults and adults usually with simple or branched dermal flaps on head and/or body, flaps essentially round in section. Without odontoid processes (Dawson and Fritzsche, 1975) in jaws. Brood pouch under tail, pouch plates absent, pouch closure the semi-type of Herald (1959). Head length ca. 10–13 in SL; snout length ca. 2.1–3.6 in HL; rings 7–12 + 49–59; dorsal-fin rays 13–17; dorsal-fin origin on 5th–9th tail ring, its base distinctly elevated, the membranes closely bound to fin rays; total subdorsal rings 2.5–4.0; pectoral-fin rays 7–10; anal-fin rays typically 2; caudal fin minute in subadults and adults, typically with 10 rays.

*Comparisons.*—Among some 22 genera of pipefishes with confluent superior trunk and tail ridges, subadults and adults of only *Urocampus* and *Siokunichthys* Herald share the combination of confluent-lateral trunk and inferior tail ridges, presence of pectoral fins and dorsal-fin origin on the 2nd–9th tail ring. *Urocampus* is characterized by the presence of a well-developed anal fin, dermal flaps on most subadults and adults and a small to rudimentary caudal fin. The anal fin and dermal flaps are lacking in *Siokunichthys* and the caudal fin is relatively long and well developed. Furthermore, the head and body ridges are distinct and rather prominent in *Urocampus*, whereas the few persistent ridges in most *Siokunichthys* are low or vestigial and difficult to see even under  $\times 60$  magnification.

*Remarks.*—Since Günther's (1870) original description, the anal fin has been variously reported as present or absent in *Urocampus*. Although sometimes concealed within the anterior portion of the brood pouch in mature males, the anal fin is present in all examined subadults and adults. This fin is not visible in early pouch larvae but it is developed in specimens as small

as 14 mm SL. Dermal flaps occasionally are absent or lost from some specimens but they are present in most subadults and adults and are usually best developed in mature males. The caudal fin is very small and accurate counts of fin rays are difficult. Although atypical counts are not uncommon, the count is 10 in pouch larvae (of *carinirostris*) and most subadults and adults.

Duncker (1910) described *Urocampus southwelli* from two adult fish (40–45 mm TL) from Ceylon and later (1915) tentatively referred this species to the synonymy of *U. carinirostris* Castelnau. The type material is no longer available, but Duncker's (1910) description and figures show that *southwelli* (without anal fin) is distinct from *carinirostris* and it is here provisionally referred to *Siokunichthys*.

The two recognized species of *Urocampus* appear to frequent shallow coastal marine and estuarine habitats and are commonly associated with algal covered sedimentary bottoms.

### *Urocampus nanus* Günther

Figs. 1–2

*Urocampus nanus* Günther, 1870:179 (orig. descr.; Manchuria).

*Urocampus rikuzenius* Jordan and Snyder, 1901:10, pl. 7 (orig. descr.; Matsushima Bay, Japan).

*Diagnosis*.—Snout long, its length averages 2.2 in HL, trunk rings 10–12 (usually 10–11), dorsal-fin rays usually 16.

*Description*.—Dorsal-fin rays 15–17 ( $\bar{x}$  = 15.9), pectoral-fin rays 7–9 (8.2), rings 10–12 + 53–56 = 63–68 (66.2), total subdorsal rings 3.25–4.0 (3.5), dorsal-fin origin on 7th–9th (7.9) tail ring; see Tables 1–4 for additional counts. Proportional data based on 7 specimens 84.0–127.5 (105.9) mm SL follow: HL in SL 10.5–12.4 (11.5), snout length 2.4–4.0 (3.2), length of dorsal-fin base in HL 1.4–1.8 (1.6), anal ring depth in HL 4.0–6.1 (5.2), trunk depth in HL 2.1–3.3 (2.8), pectoral-fin length in HL 5.7–6.9 (6.4), length of pectoral-fin base in pectoral-fin length 1.5–2.1 (1.8).

Median dorsal snout ridge (Figs. 1–2) low to slightly concave in young and females, somewhat elevated in mature males but protrudes little above horizontal through dorsal margin of eye. Supraorbital ridges continue forward to terminate bilaterally above nares and near posterior end of median dorsal snout ridge; lateral profile of head not clearly depressed behind the eye; pectoral-fin base with two faint ridges.

Dermal flaps often distally bifurcate on dorsum of predorsal rings and profusely branched on median ventral trunk ridge, elsewhere mostly simple. Head with an enlarged barbel-like flap bilaterally near posterior end of mandible and single short flaps bilaterally above middle of opercle; pectoral-fin base with a minute flap; most trunk rings with a long flap near midline of dorsum, a short flap on or just above each lateral ridge and a long flap on

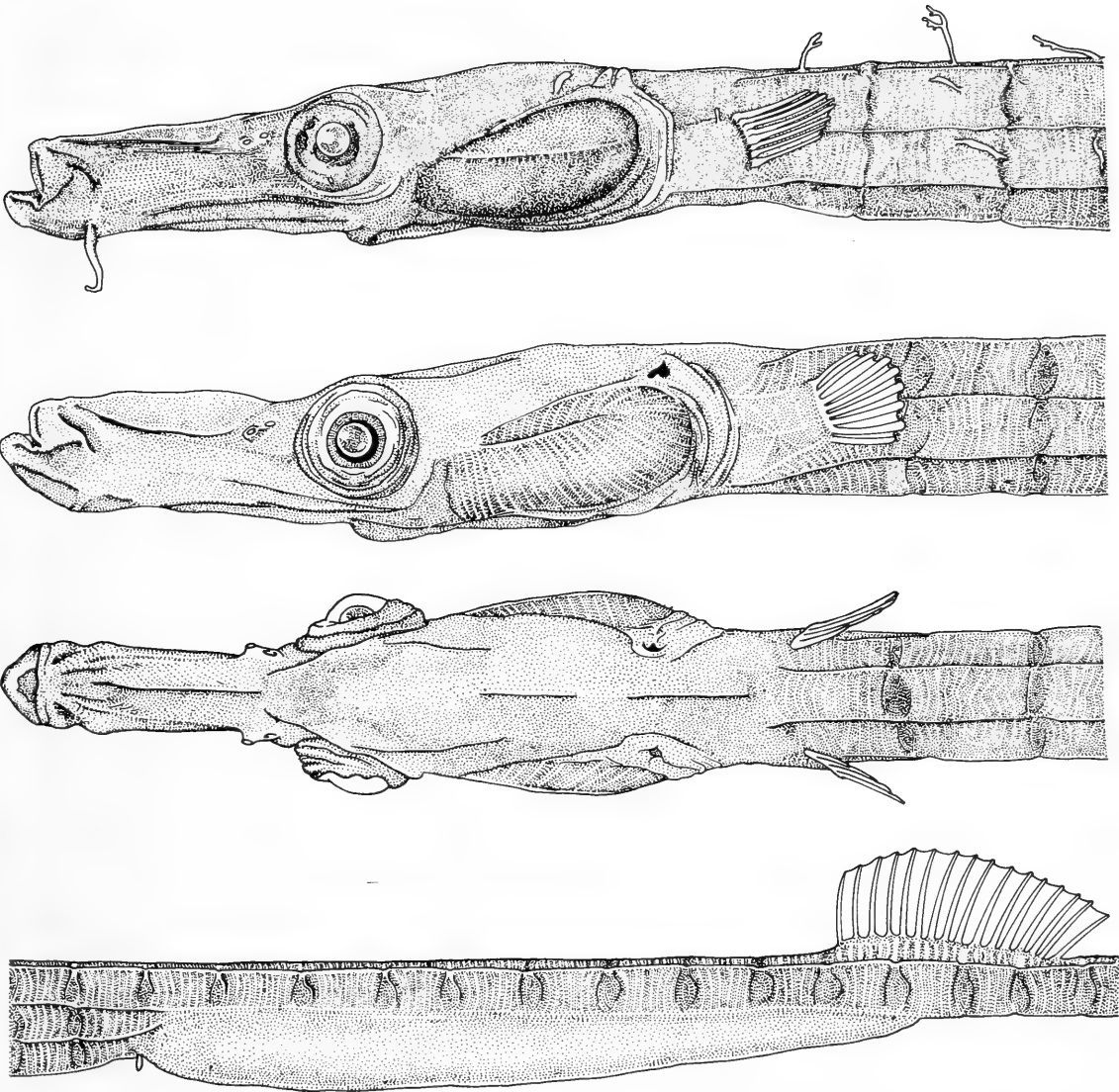


Fig. 1. *Urocampus nanus*: Lateral and dorsal aspects of head and anterior trunk rings, together with section of body illustrating ridge configuration, dorsal and anal fins, and brood pouch. **Top:** YCMP 3522 (84.0 mm SL, juvenile or female). **Remainder:** GCRL 15701 (99.5 mm SL, brooding male).

the median ventral ridge; predorsal tail rings with single median or paired bilateral flaps on the dorsum and single minute flaps just above each inferior ridge; short single or paired bilateral flaps present on dorsum to about the 9th postdorsal ring, the tail elsewhere devoid of flaps (description from YCMP 3522).

*Coloration.*—Ground color tan to dark brown, the dorsum of body often lighter than sides and venter; head and body occasionally plain but most often irregularly marked with pale mottled areas and scattered pale spots (Fig. 2); median ventral trunk ridge and associated dermal flaps mainly dark

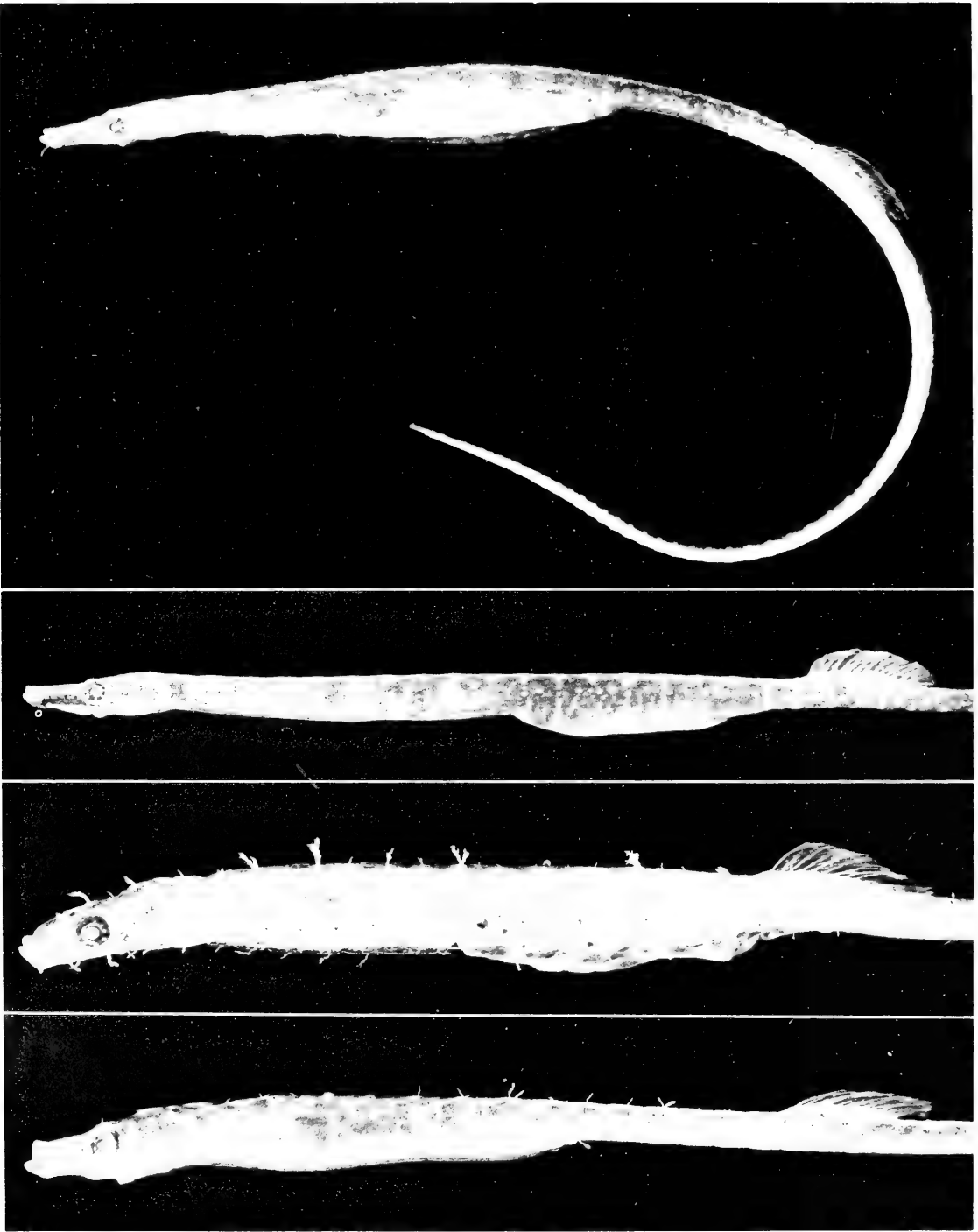


Fig. 2. **Upper pair.**—*Urocampus nanus*. **Top:** YCMP 1223 (127.5 mm SL, female). **Bottom:** GCRL 15701 (105.5 mm SL, brooding male). **Lower pair.**—*Urocampus carinirostris* GCRL 15507 (top, 72.0 mm SL, brooding male; bottom, 67.5 mm SL, female).

brown; large, more or less regularly spaced, pale spots on superior and inferior ridges of postdorsal tail rings impart a grossly banded appearance to some specimens. Dorsal and pectoral fins hyaline or the fin rays are finely peppered with brown microchromatophores, caudal fin mainly brownish.

Table 1.—Frequency distributions of trunk and tail rings in species of *Urocampus*.

Species locale	Trunk rings						Tail rings											
	7	8	9	10	11	12	49	50	51	52	53	54	55	56	57	58	59	
<i>U. nanus</i>				6	9	1					1		5	9	1			
<i>U. carinirostris</i>																		
New Guinea		1	1				1			1								
Australia																		
Queensland		9	3				3	7	2									
New South Wales	3	33	31	1				11	14	19	13	7	4					
Victoria		8	10	2							1	2	4	7	3	3		
S. Australia			1							1								
Tasmania			1														1	
W. Australia		3	5				1	1	4	1		1						

*Comparisons.*—*Urocampus nanus* has somewhat higher counts of trunk rings and dorsal-fin rays than its only known congener (usually 10–11 and 16 against 8–9 and 14 in *carinirostris*). The snout length in HL ratio is lower in *U. nanus* (averages 2.2 against 3.1 in *carinirostris*), and the snout depth in snout length and pectoral-fin length in HL ratios are both higher than those of *U. carinirostris* (respectively average 3.2 and 6.4 against 1.5 and 4.9). The median dorsal snout ridge of *U. nanus* is usually not clearly paralleled posteriad by anterior continuations of the supraorbital ridges (parallel for some distance in most *carinirostris*) and the median dorsal snout ridge of mature males is lower than that of comparable *U. carinirostris* (Figs. 1–3). The enlarged barbel-like mandibular flaps present in many *U. nanus* are

Table 2.—Frequency distributions of total rings and dorsal-fin rays in species of *Urocampus*.

Species locale	Total rings												Dorsal-fin rays				
	58	59	60	61	62	63	64	65	66	67	68		13	14	15	16	17
<i>U. nanus</i>						1		3	4	6	2				2	13	2
<i>U. carinirostris</i>																	
New Guinea	1			1										2			
Australia																	
Queensland	10	2												13			
New South Wales		3	12	22	18	7	4	2					1	74	4		
Victoria						4	6	6	2	2				14	2		
S. Australia				1											1		
Tasmania												1			1		
W. Australia	2	1	4		1								1	6	1		

Table 3.—Frequency distributions of pectoral-fin rays and subdorsal rings in species of *Urocampus*.

Species locale	Pectoral-fin rays				Subdorsal rings						
	7	8	9	10	2.50	2.75	3.00	3.25	3.50	3.75	4.00
<i>U. nanus</i>	1	21	9					6	3	7	1
<i>U. carinirostris</i>											
New Guinea			4			1		1			
Australia											
Queensland	1	9	9					2	6	4	
New South Wales	6	74	39	2		3	11	27	24	15	1
Victoria	1	15	7				4	1	5	8	2
S. Australia		2							1		
Tasmania		2						1			
W. Australia	2	3			1			4	2	1	

replaced by small and rather inconspicuous flaps in *U. carinirostris* and, when well developed, dermal flaps are generally more abundant and most profusely branched in the latter species.

*Types*.—Duncker (1915) indicated that the type material of *U. nanus* consisted of two uncataloged females in the BMNH collections but Günther’s (1870) description was based on a single 96 mm female specimen. Duncker evidently examined two fish (96–111 mm SL) now cataloged as BMNH 1863.1.22.2 and labeled “Manchuria, Adams.” The larger specimen is from an unknown locality and was added to the jar containing the holotype after 1870 (A. C. Wheeler, pers. comm.). Günther (1870) counted 11 + 50 rings

Table 4.—Frequencies of dorsal-fin origin on 5th through 9th tail rings in species of *Urocampus*.

Species locale	Tail rings														
	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50
<i>U. nanus</i>									4	2	3	3	2	2	1
<i>U. carinirostris</i>															
New Guinea											1				1
Australia															
Queensland					1	2	1		4	3	1				
New South Wales		2	9	5	13	7	11	6	13	6	7		2		
Victoria				1	2		1	1	3	3	4	1	2	2	
S. Australia					1										
Tasmania											1				
W. Australia	1		1		2	1	1	1	1		1				

and 15 dorsal-fin rays in the holotype, indicated a total of 3 subdorsal rings and stated that there was no anal fin. I count 10 trunk rings in the holotype (the anus and 2-rayed anal fin share the 11th), 53 tail rings, 16 dorsal-fin rays and 3.5 subdorsal rings. Although not mentioned in the original description, the holotype has long mandibular flaps, long flaps near the dorsal midline of most trunk rings, some flaps on the median ventral trunk ridge and there are paired bilateral flaps on the dorsum of the 1st, 4th and 7th tail rings as well as a single flap on the left side of the dorsum of the 6th.

Jordan and Snyder (1901) reported 59 tail rings and 5 subdorsal rings in the holotype of *U. rikuzenius*, whereas I find 56 tail rings and 3.75 subdorsal rings in this specimen (CAS-SU 6520).

*Remarks.*—Jordan *et al.* (1913) implied that *U. rikuzenius* was conspecific with *U. nanus* and Duncker (1915) tentatively referred *rikuzenius* to the synonymy of the latter species. These early statements have been largely ignored or overlooked and most recent authors have incorrectly employed the specific name *rikuzenius*.

Among the study material, dermal flaps are abundant and well developed on the holotype and an 84 mm juvenile or female, in some specimens only the mandibular flaps persist, and flaps are absent from two mature males (95.5–105.5 mm SL). Well-developed flaps were noted in smaller fish (45.5–75.2 mm SL) by Takai and Mizokami (1961).

The brood pouch extends below 9–11 rings in three males examined (95.5–105.5 mm SL). The largest specimen has eggs in about four crowded transverse rows and in 1–2 layers; there are about 17 eggs in the outer left row through 6 of the 9 pouch rings. Takai and Mizokami (1961) reported two layers of two rows of pouch eggs in a 62.4 mm male, noted that the ovoid pouch eggs were about  $0.5 \times 0.7$  mm in diameter, and counted 69 ovarian eggs in each of two females (45.5–75.2 mm SL).

Examined materials include few data on depth of collections or habitat but *U. nanus* is evidently most common in protected shallow inshore environments. The species was reported as a year-round resident of the *Zostera* zone in the Amakusa Islands by Kikuchi (1968, 1970) and additional notes on habits and behavior were provided by Takai and Mizokami (1961). The holotype was reportedly collected in “Manchuria” and, without additional evidence, this was interpreted to be “in Yellow Sea off coast of northeast China” by Lindberg and Legeza (1965).

Although the type locality is uncertain and the geographic range is presently undefined, *U. nanus* has been reported from Pusan and Masan, Korea (Mori, 1952) and from Sado Island and Matsushima to Kôchi Prefecture, Japan (Kamohara, 1964). The southernmost record is evidently represented by 4 specimens (FMNH 83875) reportedly collected in the Haneji River, Okinawa (ca. 26°35'N, 128°05'E).

*Material examined.*—17 specimens, 84–133 mm SL, including holotype.



*Holotype*.—BMNH 1863.1.22.2 (96.0 mm SL, female), Manchuria, A. Adams.

*Other material*.—KOREA, Fusan: UMMZ 205279 (1, 101.5). JAPAN, Kyoto Pref.: GCRL 15701 (2, 99.5–105.5). Kanegawa Pref.: UMMZ 205271 (3, 111.5–133), UMMZ 205274 (1, 130), YCMP 1223 (1, 127.5), YCMP 3522 (1, 84). Kagoshima Pref.: CAS-SU 6520 (117.5, holotype of *U. rikuzenius*). Okinawa: FMNH 83875 (4, 99–112). Loc. uncertain: USNM 70773 (1, 103). LOC. UNKNOWN: BMNH 1863.1.22.2 (1, 111).

*Urocampus carinirostris* Castelnau

Figs. 2–4

*Urocampus carinirostris* Castelnau, 1872:200 [orig. descr.; Melbourne (Australia)].

*Urocampus coelorhynchus* Günther, 1873:103 [orig. descr.; Sydney (Australia)].

*Urocampus Güntheri* Duncker, 1909:242, figs. 1–2 (orig. descr.; Sharks Bay, W. Austr.).

*Urocampus carinorostris*. Coleman, 1933:87 (Misspelling).

*Urocampus guentheri*. Whitley, 1948:14 (emended spelling).

*Stigmatophora boops* (not of Castelnau). Bertin and Estéve, 1950:50 (misidentification).

*Diagnosis*.—Snout short, its length averages 3.1 in HL; trunk rings 7–10, usually (94%) 8–9; dorsal-fin rays usually (92%) 14.

*Description*.—Dorsal-fin rays 13–15 ( $\bar{x}$  = 14.0), pectoral-fin rays 7–10 (8.3), rings 7–10 + 49–59 = 58–68 (62.0), total subdorsal rings 2.5–4.0 (3.4), dorsal-fin origin on 5th–8th (6.6) tail ring; see Tables 1–4 for additional counts. Proportional data based on 32 specimens 56.0–95.0 (66.5) mm SL follow: HL in SL 9.7–13.1 (10.8), snout length in HL 2.8–3.6 (3.1), snout depth in snout length 1.3–1.8 (1.5), length of dorsal-fin base in HL 1.2–1.7 (1.6), anal ring depth in HL 2.3–4.6 (3.5), trunk depth in HL (3 fish) 1.9–2.4, pectoral-fin length in HL 3.9–6.4 (4.9), length of pectoral-fin base in pectoral-fin length 1.4–2.2 (1.7).

Median dorsal snout ridge (Figs. 2–3) more or less linear to slightly concave in females, not elevated to or above horizontal through dorsal margin of eye; ridge clearly convex and usually elevated to or above dorsal margin of eye in mature males. Supraorbital ridges continued anteriad on each side of median snout ridge to near vertical from nares; lateral profile of head depressed behind the eye but somewhat elevated over posterior part of head.

Dermal flaps simple or irregularly branched distally. In well-preserved males, head flaps may include long branched flaps over eye and on suborbital and short simple or branched flaps below angle of gape, on ventral

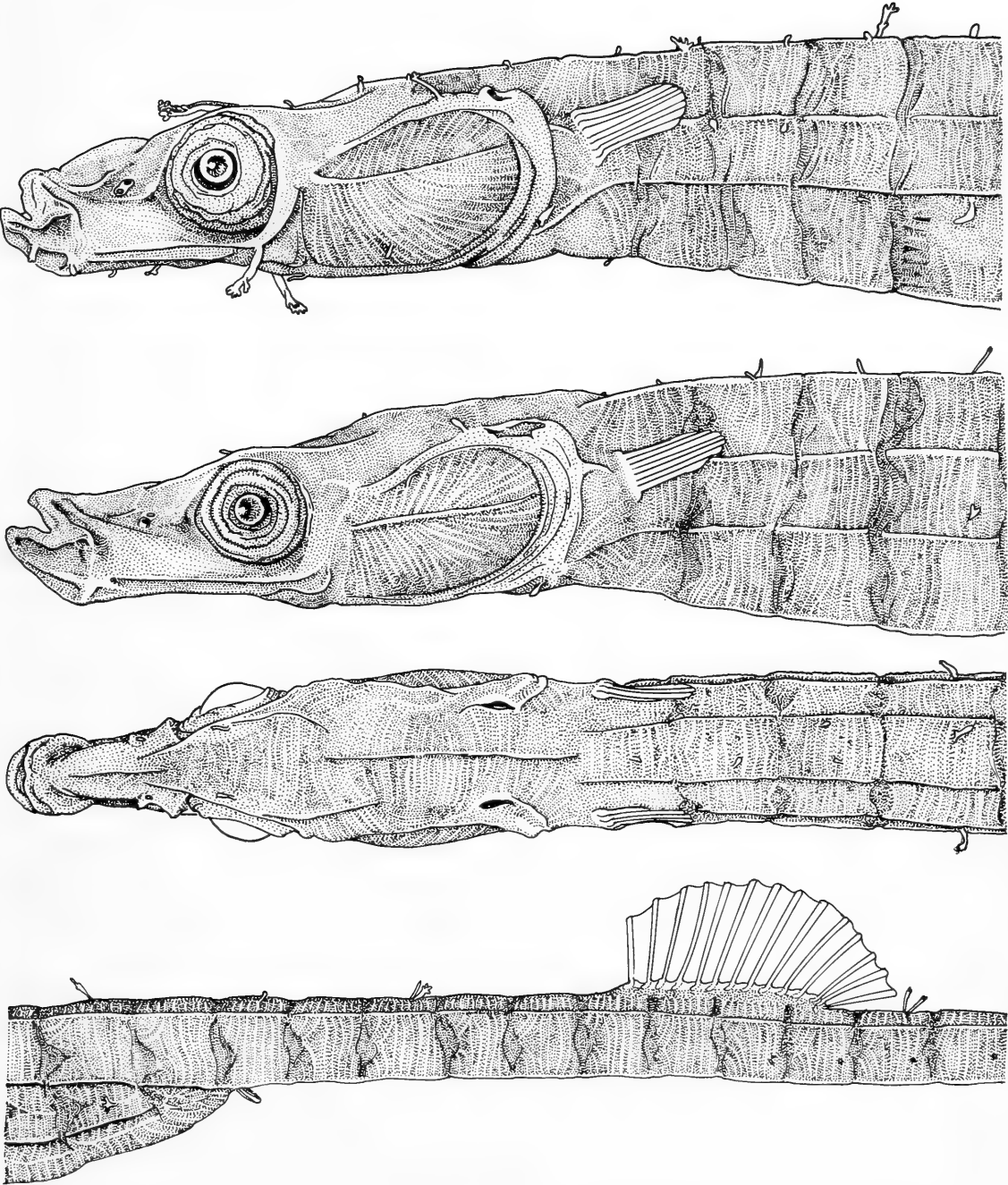


Fig. 3. *Urocampus carinirostris*: Lateral and dorsal aspects of head and anterior trunk rings, together with section of body illustrating ridge configuration and dorsal and anal fins. **Top:** 64.5 mm SL, male. **Remainder:** 66.5 mm SL, female (GCRL 14799).

midline of snout, on median dorsal snout ridge, on lower half of opercle and opercular membrane, as well as on the posterior part of the supraorbital ridge and on the frontal ridge. In females, head flaps are usually reduced to short simple flaps on the supraorbital and frontal ridges. In males, each trunk ring may have a pair of long bilateral flaps on the dorsum, a long flap

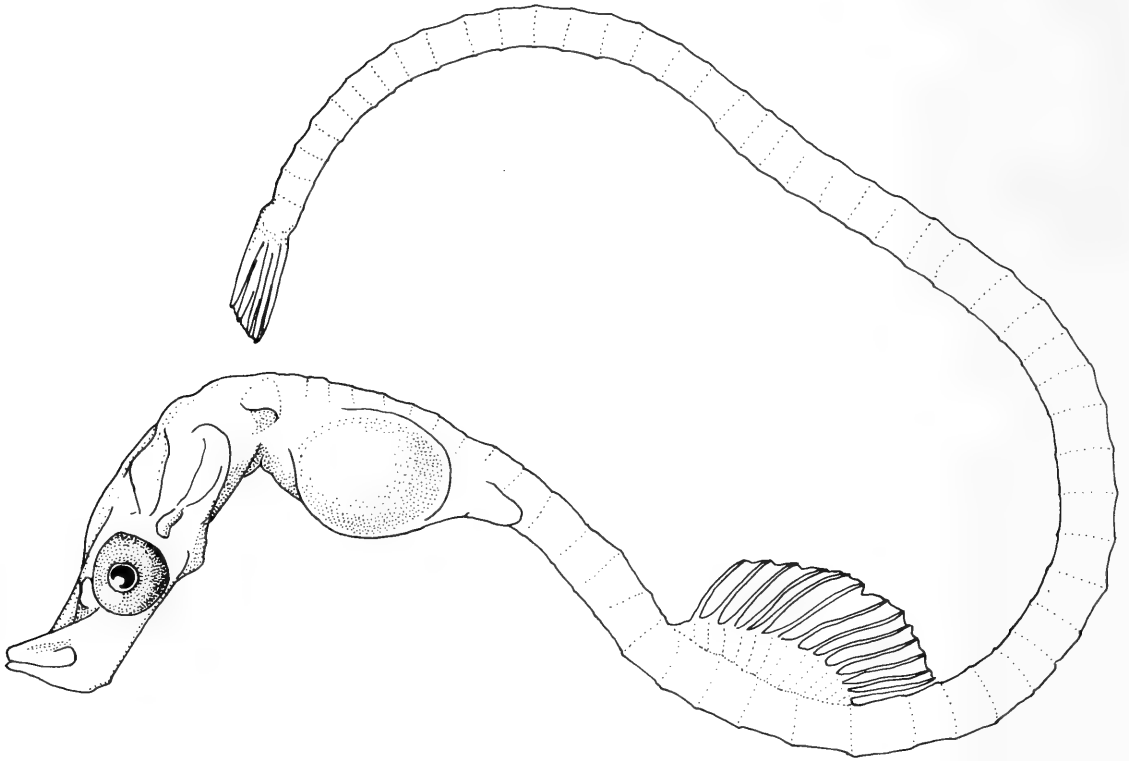


Fig. 4. Partially straightened brood-pouch larva of *Urocampus carinirostris* (ca. 11.5 mm TL).

on each lateral ridge and one on the median ventral ridge; tail flaps are usually confined to the anterior 20–25 rings and each ring may bear paired flaps on the dorsum and single long flaps on the inferior ridges which, on anterior 5–8 rings, may be accompanied by a row of 4–7 minute simple flaps. Flaps are usually absent from the median ventral trunk ridge in females and those on the dorsum and sides of body are typically shorter and less obvious than those of males.

*Coloration*.—Ground color tan to dark brown; head mainly mottled with pale, often with a dark brown stripe on ventral midline; sides and dorsum of body plain or mottled, occasionally with indications of narrow pale bars (ca. 1–2 rings wide) crossing dorsum of trunk and anterior part of tail; venter often with dark brown stripe on midline of trunk but elsewhere plain or mottled. Dorsal-fin rays usually with 2–5 brown spots, the membrane hyaline; pectoral fin shaded lightly with brown; caudal fin brownish, often margined with pale.

*Comparisons*.—See under *U. nanus*.

*Types*.—Castelnau (1872) failed to designate type material but his description indicates that both males and females were examined, that the largest specimen was “three and a-half inches” (TL) and that the species was rather common. Examination of pipefishes in the Paris collection shows that the 10 fish in MNHN A.1435, listed as “paratypes” of *Stigmatophora boops*

Castelnau by Bertin and Estéve (1950), are actually *Urocampus carinirostris*. These specimens, including males and females (52–72 mm SL) labeled “Australia, Yarra River, Castelnau,” are here considered to be the presumptive syntypes of *U. carinirostris*. Both *carinirostris* and *boops* were treated by Castelnau (1872) and subsequent errors in labeling or cataloging appear certain. The holotype of *U. Güntheri* Duncker, deposited in the Hamburg Museum, has been destroyed.

*Remarks.*—McCulloch (1909) incorrectly reported the presence of 4 lateral ridges on the body (trunk) of *U. carinirostris* and implied that a pair of these were confluent with the inferior tail margin. Evidently misled by McCulloch’s description, Munro (1958) reported a “double” lateral trunk ridge in this species and Scott (1961) employed this nonexistent “double” ridge as a differentiating character in his key to the Tasmanian Syngnathidae.

Examined Australian collections include brooding males taken in Western Australia (Feb., Oct.), Victoria (Nov.), New South Wales (Feb., Apr., Sept., Oct., Dec.) and Queensland (July). Scott (1971) noted brooding males collected in Tasmania during April.

The brood pouch extends below 8–11 (usually 9–10) anterior tail rings in 34 examined males 45–95 mm SL. The free margins of the pouch membranes are usually edged with narrow, laterally directed, folds and the margins meet or, more commonly, fail to meet on the ventral midline of the egg-filled pouch. Pouch eggs are usually deposited in a single layer of 1–4 transverse rows and are often absent from the posteriormost pouch rings. The smallest examined brooding male (48 mm SL) contained only 2 eggs in the 8-ring pouch, a 57.5 mm fish had 2 rows of 19 eggs through 8 of 10 pouch rings, and there were 4 rows of 17 eggs through 9 of 10 rings in a 76 mm specimen. Rather large (ca. 10–14 mm TL) larvae (Fig. 4) are often found coiled within the open membranous compartments lining the sides and dorsum of the brood pouch. The anal fin and pectoral-fin rays are not evident at  $\times 60$  magnification in 11–12 mm pouch larvae but they are distinct in a 14 mm specimen and the dorsal and caudal fins are well developed in 10 mm larvae. The 14 mm larva had the head and body peppered with brown microchromatophores and about 6 narrow brown bands encircled the tail behind the dorsal fin.

There were 7–9 trunk rings in 57 adult males and the count was 8 in 82%, whereas the range was 8–10 in 50 adult females and the modal value was 9 (88%). Other meristic data (Table 1) suggest clinal variation wherein tail ring frequencies are highest in samples from Tasmania and Victoria and lowest in material from New Guinea, Queensland and Western Australia. Additional study is required for confirmation of this apparent trend in *U. carinirostris* but similar geographic variation is indicated (author’s unpublished data) for other Australian pipefishes.

Although dredge collections among *Zostera* sp. were noted by Scott

(1965), the majority of examined material was seined in depths to ca. 3 m and all collections appear to be from the lower reaches of rivers, estuaries or other protected inshore habitats. A number of samples indicate that collections were from areas of algae or *Zostera*. This is a small pipefish which probably seldom attains 100 mm SL. The species is presently known only from Australia and New Guinea. Examined Australian specimens were collected along southern coasts from Narang, Queensland (ca. 24°53'S, 151°48'E) to Crawley Bay, Swan River, Western Australia (ca. 32°01'S, 115°48'E).

*Material examined.*—151 specimens (excluding pouch larvae), 35.5–95.0 mm SL, including 10 presumptive syntypes.

*Presumptive syntypes.*—MNH A.1435 (10, 52.0–72.0 mm SL), Yarra River, Victoria, Australia, F. de Castelnau.

*Other material.*—NEW GUINEA, Tobriand Is.: AMS I.107095-010 (1, 59.5), USNM 215314 (1, 67). AUSTRALIA, Queensland: QM I.8729 (1, 51), QM I.8733 (1, 64.5), QM I.13379 (4, 59.5–65.5), QM I.-6705 (7, 51–63.5). New South Wales: AMS I.16475-017 (1, 63.5), AMS I.19488-001 (1, 71), BMNH 1873.4.3.74-5 (2, 84–95, syntypes of *Urocampus coelorhynchus*), BMNH 1873.4.3.210 (1, 88), BMNH 1890.2.26.199 (1, 58), GCRL 14799 (5, 62.5–71), GCRL 15506 (1, 71.5), GCRL 15507 (7, 64–72), GCRL 16268 (1, ca. 55.5), GCRL 16357 (4, ca. 51–69), GCRL 16367 (2, 54.5–57), GCRL 16371 (2, ca. 35.5–47.5), GCRL 16373 (2, 36–63.5), GCRL 16378 (8, 38–76), GCRL 16448 (35, 47–58.5), USNM 215308 (7, 55–64), USNM 215309 (1, 67), USNM 215310 (20, 37–68). Victoria: NMV A.551 (8, 50.5–91), NMV A.555 (1, 79), QM I.16657 (2, 56.5–65). South Australia: CAS 36433 (1, 68.5), SAM F.3441 (1, 65.5). Tasmania: GCRL 14766 (1, 93), QVM 1968.5.33 (1, 84). Western Australia: AMS IA.7445-8 (4, 49.5–65.5), AMS I.15724-007 (1, 64), NMV A.696 (2, 63.5–73.5), WAM P.25701-001 (1, 55), WAM P.26473-001 (1, 50), WAM P.26475-001 (1, 50).

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NEW FRESHWATER SHRIMP RECORDS FOR TOBAGO,  
WEST INDIES, WITH A SUMMARY OF RECORDS  
FOR THE LESSER ANTILLES  
(Atyidae and Palaemonidae)

C. W. Hart, Jr.

*Abstract.*—Collections made on Tobago, W.I., in April 1978 increased the known freshwater shrimp fauna of that island to 10 species—*Atya innocuous*, *A. scabra*, *Jonga serrei*, *Potimirim glabra*, *Xiphocaris elongata*, *Macrobrachium acanthurus*, *M. carcinus*, *M. crenulatum*, *M. faustinum*, and *Palaemon (P.) pandaliformis*. Before that time only 2 freshwater shrimp species were known from Tobago.

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In April, 1978, several staff members<sup>1</sup> from the Chesapeake Biological Laboratory of the University of Maryland carried out a 2-week fisheries survey of near-shore and freshwater habitats on Tobago, West Indies. M. L. Wiley was primarily responsible both for collecting the decapods and sending them to Austin B. Williams of the National Marine Fisheries Service Systematics Laboratory, Washington, D.C. Subsequently, Dr. Williams made the freshwater shrimps available to me.

I thank Drs. Wiley and Williams; Mr. Hardy, who initiated the survey; and Mr. H. E. Wood, Senior Fisheries Officer, Ministry of Agriculture, Land and Fisheries Division, Port-of-Spain, Trinidad, who gave permission for the survey to be made.

Collections containing palaemonid and atyid shrimps were made at 6 localities (Fig. 1) on Tobago; night and daytime collections were made at Station C; and rotenone was used to aid in collecting at Station B.

The station localities are as follows:

- A.—Bloody Bay River, lower coastal lagoon just above beach. 6 April 1978. 11°18'N; 60°38'W.
- B.—Bloody Bay River at barrier beach pool (collected with rotenone). 15 April 1978. 11°18'N; 60°38'W.
- C.—Doctor's River, in small dammed pond near Speyside (collections made in daylight and at night). 9 April 1978. 11°18'N; 60°32'W.
- D.—Merchiston River, below Windward Highway down to barrier pool. 9 April 1978. 11°16'N; 60°32'W.

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<sup>1</sup> J. D. Hardy, Jr., leader; L. Lubbers III; F. D. Martin; D. Shelton; and M. L. Wiley.



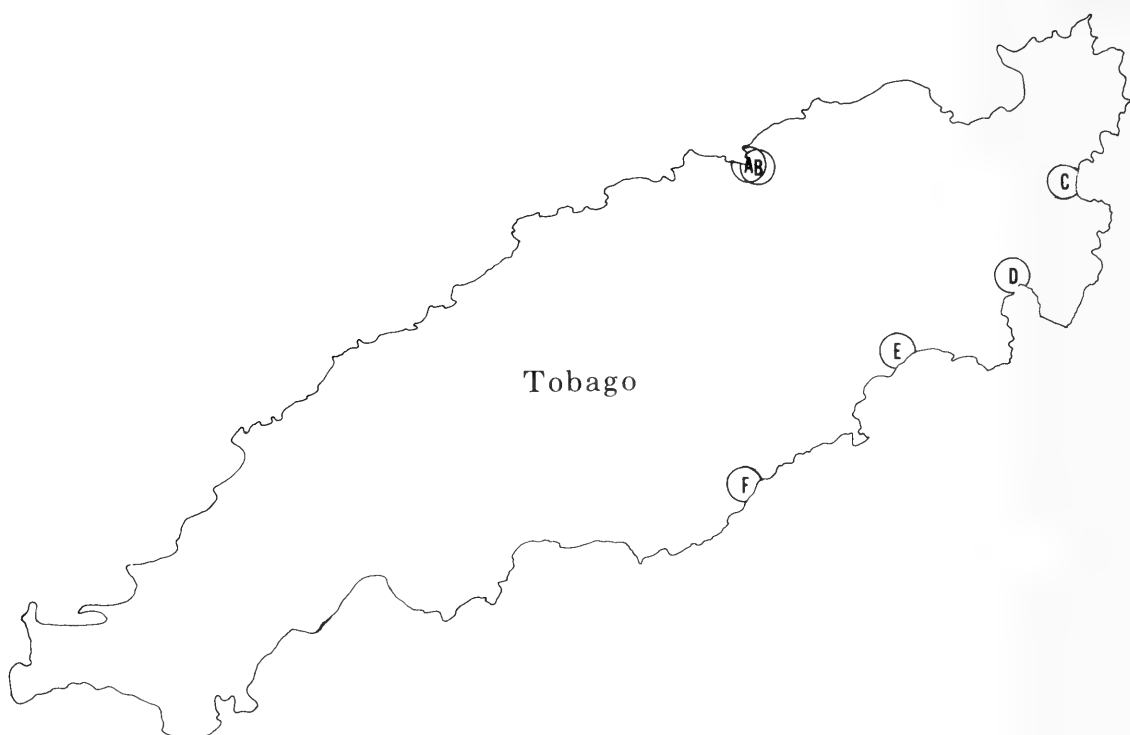


Fig. 1. Tobago, W. I., showing locations of collecting stations.

E.—Roxborough River, about 1 mile N of windward Highway. 9 April 1978.  $11^{\circ}14'N$ ;  $60^{\circ}35'W$ .

F.—Goldsborough of Great River, just upstream of bridge at Windward Highway. 7 April 1978.  $11^{\circ}12'N$ ;  $60^{\circ}38'W$ .

Some 200 specimens of caridean shrimps, representing 8 species in 6 genera, were collected from the 6 localities. Data concerning the species are given in Table 1.

When Chace and Hobbs (1969) summarized the available information on freshwater and terrestrial decapods of the West Indies, they mentioned *Macrobrachium faustinum* as the only freshwater shrimp having been recorded from Tobago. Later, a record of *Atya scabra* was discovered by Hobbs (Ortman, 1895), and this, together with the 8 species collected by the Chesapeake Biological Laboratory team, bring the island total of known caridean shrimp species to 10 (Table 2).

In discussing the Antillean distribution of the monotypic genera *Jonga* and *Micratya*, Chace and Hobbs (1969:20) surmised that those species reached the Greater Antilles from the Central American-Mexican region and spread southeastward. They based their reasoning on the observation that *Jonga* and *Micratya* were apparently absent from the lower islands of the Lesser Antillean chain and from South America. The new information does

Table 1.—Data on the 8 species of freshwater caridean shrimps collected on Tobago, W.I., in April 1978.

Species	Sex	Stations						Postorbital carapace lengths (mm)	
		A	B	C	D	E	F	Range	Means & standard deviations
<i>Jonga serrei</i>	♂	—	2	5	—	—	1	2.25–3.50	2.68 ± 0.36
	♀ (total)	2	10	5	1	—	6	3.5–6.0	4.59 ± 0.71
	♀ (ovig.)	(2)	(10)	—	—	—	—	3.5–4.75	4.16 ± 0.45
<i>Potimirim glabra</i>	juv.	—	—	2	—	—	—	3.0, 3.0	
	♂	—	—	19	—	—	—	3.75–4.75	4.07 ± 0.22
<i>Xiphocaris elongata</i>	♀	—	—	11	—	—	—	5.25–7.0	5.89 ± 0.62
	♂	—	—	5	—	—	—	9.5–11.5	10.60 ± 0.82
<i>Atya innocous</i>	♀	—	—	6	—	—	—	11.0–12.75	12.10 ± 0.55
	♂	—	—	4	—	—	—	17.0–29.0**	24.0 ± 4.6
<i>Macrobrachium carcinus</i>	♂	—	—	4	—	—	—	11.0–29.25	16.69 ± 7.4
	♀	—	—	2	—	—	—	12.0, 34.0	
<i>Macrobrachium crenulatum</i>	juv.	—	***	*	—	*****	—		
	♂	—	—	2	—	—	—	17.0, 17.75**	
<i>Macrobrachium acanthurus</i>	♀	—	—	2	—	—	—	14.0, 16.75	
	juv.	—	—	*	—	*****	—		
<i>Palaemon (P.) pandaliformis</i>	♂	—	—	—	—	—	3	9.0, 12.75, 18.5	
	♀	—	—	—	—	—	6	10.0–21.0	14.16 ± 3.58
<i>Palaemon (P.) pandaliformis</i>	juv.	—	—	*	*****	*****	—		
	♂	—	—	—	1	—	3	4.0–6.0	4.56 ± 0.84
<i>Palaemon (P.) pandaliformis</i>	♀ (total)	—	—	—	—	—	19	3.5–7.5	5.14 ± 0.75
	♀ (ovig.)	—	—	—	—	—	(4)	5.0–6.0	5.38 ± 0.41

\* 26 *Macrobrachium* sp. (juvenile or without chelae) collected in daytime; 25 at night.  
\*\* Largest specimens collected at night.  
\*\*\* 9 juvenile *Macrobrachium* specimens, possibly *M. carcinus*.  
\*\*\*\* 11 juvenile *Macrobrachium* specimens, possible *M. acanthurus*.  
\*\*\*\*\* 8 juvenile *Macrobrachium* sp. specimens.

Table 2.—Summary of freshwater shrimp records for the Lesser Antilles.

	<i>Atya innocens</i>	<i>Atya scabra</i>	<i>Jonga serrai</i>	<i>Micratya poeyi</i>	<i>Polimirim polimirim</i>	<i>Polimirim americana</i>	<i>Polimirim glabra</i>	<i>Xiphocaris elongata</i>	<i>Macrobrachium acanthurus</i>	<i>Macrobrachium carcinus</i>	<i>Macrobrachium crenulatum</i>	<i>Macrobrachium faustinum</i>	<i>Macrobrachium heterochirus</i>	<i>Palaemon (P.) pandaliformis</i>	<i>Typhlatya monae</i>
St. Martin								●	●						
Barbuda															●
Montserrat	●														
Guadeloupe	●	□	□	□			□	□	□	●	□	●		□	
Dominica	●	●	●	●			●	●	●	●	●	●			
Martinique	●			●				●							
St. Lucia							●		●		●				
St. Vincent	●										●	●			
Barbados			●				●		●		●			●	
Grenada									●	●	●				
Tobago	☆	▲	☆				☆	☆	☆	☆	●			☆	
Trinidad		●			●				●	●			●		
Bonaire									●		●				
Curacao									●		●				
Aruba									●						

● Chace & Hobbs    □ Lévêque    ▲ Ortman    ☆ New Tobago records

not dispute this conclusion as it relates to *Micratya*, but the occurrence of *Jonga* on Tobago leads one to believe that it may have entered the Antillean chain from either Central or South America. The presence of *Jonga* on an island so close to South America suggests that it may also be present, but overlooked, in the mainland waters of the continent.

Reports of the behavior of another shrimp (H. E. Wood, personal communication) found in areas away from the coastline, indicate that *Macrobrachium heterochirus* is, in all probability, also to be found on Tobago.

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## TWO NEW PHOXOCEPHALID GENERA, *FUEGIPHOXUS* AND *PHOXORGIA*, FROM MAGELLANIC SOUTH AMERICA (AMPHIPODA: CRUSTACEA)

J. L. and C. M. Barnard

*Abstract.*—*Parharpinia fuegiensis* Schellenberg, 1931, from Magellanic South America, is made the type-species of *Fuegiphoxus* a new genus generally in the Brolginae, a dominantly Australian subfamily. *Fuegiphoxus* appears to be a plesiomorph of the Australian *Elpeddo*. Two new Magellanic species are added to *Fuegiphoxus* along with the Antarctic *Pontharpinia uncinata* Chevreux, 1912. *Phoxorgia* is described for *Parharpinia sinuata* K. H. Barnard, 1931, and appears to be plesiomorphic both to the Australia *Parharpinia* and the predominantly North American *Metharpinia*.

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Two more new genera of Phoxocephalidae are now extracted from the polytypic *Paraphoxus* Sars, a genus which should be reduced to 2 species (see Barnard and Drummond, 1976, 1978 and J. L. Barnard, 1979, 1980).

We thank Dr. Charlotte Holmquist of the Swedish Museum of Natural History for loaning us Schellenberg's (1931) material for the second time in 25 years. We hope this time will be the last and that the species are now adequately analyzed. We thank Elizabeth B. Harrison, Janice Clark, Irene F. Jewett and Roland H. Brown for their considerable help. Dr. Wim Vader of Tromsø offered valuable advice.

Antecedents for styles and methods of description are found in Barnard and Drummond (1978).

### Key to Illustrations

Capital letters refer to appendages and parts of the amphipod; lower case letters to left of capitals refer to specimens cited in legends and Voucher Material; lower case letters to right of capitals or within parts refer to conditions as listed below: **A**, antenna; **B**, buccal complex, lateral view; **D**, dactyl of a pereopod; **E**, epimeron; **F**, accessory flagellum; **G**, gnathopod; **H**, head; **I**, inner plate or ramus; **L**, lacinia mobilis; **M**, mandible; **N**, molar; **O**, outer plate or ramus; **P**, pereopod; **R**, uropod; **S**, maxilliped; **T**, telson; **U**, upper lip; **W**, pleon; **X**, maxilla; **Y**, palp of mandible. **b**, broken; **d**, dorsal; **l**, left; **m**, medial; **p**, apex of peduncle; **r**, right; **s**, setae removed.

### *Fuegiphoxus*, new genus

*Diagnosis.*—Eyes present. Flagella of antennae 1-2 unreduced in female, article 2 of antenna 1 shortened to ordinary, ventral setae confined apically.

Article 1 of antenna 2 not ensiform, article 3 with 2 setules, facial spines on article 4 in one main row or 2 rows, article 5 ordinary in size. Right mandibular incisor with 3 teeth, molar not triturative, small, pillow-shaped, bearing 2 short and one elongate spines, not bearing patch of pubescence, palpal hump small. Palp of maxilla 1 biarticulate, inner plate with 4 setae. Setation of maxilla 2 ordinary. Inner plate of maxilliped ordinary, apex of palp not strongly protuberant, dactyl elongate, apical nail distinct, medium. Gnathopods small but dissimilar, gnathopod 2 weakly to moderately enlarged, article 5 of gnathopod 1 of ordinary length but on gnathopod 2 very short and almost cryptic, without eusirid attachment, palms oblique, hands of gnathopods 1–2 respectively ovato-rectangular and slightly broadened, poorly setose anteriorly. Article 2 of pereopod 5 of broad form, articles 4–5 of pereopods 5–6 narrow to medium, article 2 not setose posteriorly, pereopod 7 ordinary, article 2 naked ventrally, article 3 ordinary, dactyl normal. Peduncle of uropod 1 normally elongate, without apical spike, without displaced apical spine, only peduncular apices of uropods 1–2 with faint comb, inner ramus of uropod 1 with one row of marginal spines, no rami continuously spinose to apex, inner ramus of uropod 2 ordinary, uropod 3 ordinary, bearing article 2 of outer ramus, carrying 2 medium to long apical setae. Telson ordinary, each lobe with 2 apical spines plus setules on each lobe, without special dorsal and lateral spines or setae. Epimera 1–2 bearing sparse short posterior setae, without midfacial setae above ventral facial ridge, epimeron 3 ordinary, bearing 3 or more long setae. Urosomite 1 without large lateral armament, bearing or lacking one or more midventral crescents or bundles of setae. Urosomite 3 without dorsal hook or process.

*Description*.—Rostrum fully developed, unconstricted. Pubescence on article 1 of antenna 1 in male present; calceoli on male primary flagellum of antenna 1 present, calceoli on article 5 of male antenna 2 present, flagellum in male with calceoli. Prebuccal parts ordinary. Right lacinia mobilis bifid, subflabellate, article 1 of mandibular palp short to slightly elongate, palp thin, apex of article 3 oblique, article 2 without outer setae. Lower lip bearing cones. Outer plate of maxilla 1 with 10–11 spines, one spine especially thickened. Inner plates of maxillipeds with one main spine, ordinarily setose. Coxae 2–4 without special anterodorsal humps. Posterior spines on article 6 of pereopods 3–4 thick and stiff, midapical spine or seta absent; article 2 of pereopod 7 without facial setae. Peduncle of uropod 1 with dorsolateral spines confined apically (possibly widely spread on *uncinata*), medial spines widely spread. Peduncle of uropod 2 with only one medial spine confined apically, peduncle of uropod 3 lacking extra subapical setae or spines. Telson with ordinary pair of midlateral or dorsal setules on each side.

*Etymology*.—From “Tierra del Fuego,” modified for euphonic reasons and from “*Phoxocephalus*,” the type-genus of the family. Masculine.

*Type-species.*—*Parharpinia fuegiensis* Schellenberg, 1931.

*Composition.*—*Pontharpinia uncinata* Chevreux, 1912; *Fuegiphoxus inutilis*, new species; *F. abjectus*, new species.

*Remarks.*—*Fuegiphoxus* differs from *Paraphoxus* Sars in the: (1) weak division of the spine rows on article 4 of antenna 2; (2) proximal position of the dorsal notch on article 4 of antenna 2; (3) elongation of the third spine on the mandibular molar; (4) presence of 4 (not 2) setae on the inner plate of maxilla 1; (5) presence of a thick apical spine on the inner plate of the maxilliped; (6) elongate article 5 of gnathopod 1; (7) significantly enlarged gnathopod 2; (8) cryptic article 5 of gnathopod 2; (9) well developed facial setae on articles 4–5 of pereopods 3–4; (10) apical digitation of article 6 on pereopod 7; and (11) lowered flexibility of the apical nail on the rami of uropods 1–2.

*Fuegiphoxus* differs from *Wildus* Barnard and Drummond in the: (1) clear division of spines into rows on article 4 of antenna 2; (2) slightly longer article 5 of antenna 2; (3) diversity of spine size on the mandibular molar; (4) presence of 4 setae on the inner plate of maxilla 1 and the presence of 11 spines on the outer plate (not 9); (5) presence of the thick spine on the inner plate of the maxilliped; (6) deeper cleft on the inner plates of the maxillipeds; (7) incompleteness of the cryptic condition on the wrist of gnathopod 2; (8) strong facial setation on articles 4–5 of pereopods 3–4; (9) retention of apical digits on article 6 of pereopod 7; (10) presence of ventral setae on epimeron 3; and (11) deeply immersed apical nails on the rami of uropods 1–2. In addition the type-species of *Fuegiphoxus* has more basofacial setae on the peduncle of uropod 1 (also satisfactory in *inutilis* but unknown in *uncinatus*) and the nondisplacement of the apicomedial spine on the peduncle of uropod 1 (unknown in *uncinatus* and see *W. waipiro*, an exception to the *Wildus* pattern). Generally, *Fuegiphoxus* has a more proximal dorsal notch on article 4 of antenna 2 and larger outer plates of the maxillipeds.

*Fuegiphoxus* resembles *Eyakia* J. L. Barnard in the elongation of one spine on the mandibular molar but differs from *Eyakia* in the: (1) short thick article 2 on antenna 1; (2) additional proximal spine(s) in the formula on article 4 of antenna 2 (but unknown in *uncinata*); (3) absence of pubescence on the molars; (4) presence of only one (not 2) main spine on the inner plate of the maxilliped; (5) distinctly enlarged gnathopod 2; (6) untapered article 2 of pereopod 5; (7) poorly setose epimeron 3; and (8) more immersed apical nails on the rami of uropods 1–2.

*Elpeddo* Barnard and Drummond (1978) in Australia may be an apomorph of *Fuegiphoxus* because that monotypic genus has a peculiar male antenna 1 like the appendage of *Fuegiphoxus abjectus*. *Elpeddo* differs from *Fuegiphoxus* in the loss of 2 of the 4 setae on the inner plate of maxilla 1, the loss of the main spine on the inner plates of the maxilliped, has developed



a displaced spine on the apicomedial margin of the peduncle on uropod 1, has giant calceoli on article 5 of antenna 2 and bears the neotenic or juvenile form of uropod 3 in which article 2 on the outer ramus is elongate.

### Key to the Species of *Fuegiphoxus*

1. Epimeron 3 with long thin blunt posterior teeth ..... *F. uncinatus*  
Epimeron 3 rounded or broadly quadrate posteriorly ..... **2**
- 2a. Epimera 1–2 with small posteroventral tooth, spine formula on article 4 of antenna 2 = 0-4-4-1 ..... *F. inutilus*
- 2b. Epimera 1–2 rounded posteroventrally, spine formula on article 4 of antenna 2 = 0-6-1 ..... *F. fuegiensis*
- 2c. Epimera 1–2 subquadrate posteroventrally, spine formula on article 4 of antenna 2 = 3-3-3-1 ..... *F. abjectus*

### *Fuegiphoxus fuegiensis* (Schellenberg)

Figs. 1–3 (part)

*Parharpinia fuegiensis* Schellenberg, 1931:78–80, fig. 40.—Stephensen, 1949:5–6.

*Paraphoxus fuegiensis*.—J. L. Barnard, 1960:271, pl. 42.

*Description of lectotype female “f.”*—Head about 20 percent of total body length, greatest width about 75 percent of length, rostrum unconstricted, broad, short, reaching middle of article 2 on antenna 1; eyes large, clear of pigment, ommatidia ordinary; article 1 of peduncle on antenna 1 almost 1.5 times as long as wide, about twice as wide as article 2, ventral margin with about 12 setules (not all illustrated), produced dorsal apex with 3 setules, article 2 about 0.55 times as long as article 1, with apicoventral cycle of 7–8 setae, primary flagellum with 10 articles, about 0.8 times as long as peduncle, bearing one short aesthetasc on each of articles 4–9, accessory flagellum short, with 7 articles. Spine formula of article 4 on antenna 2 = 3-3-2, dorsal margin with notch bearing 4 setae, ventral margin with 5–6 groups of 1–4 long to medium setae, one ventrodistal long spine, article 5 about 0.7 times as long as article 4, facial spine formula = 1, dorsal margin bearing one set of small setae, ventral margin with 3 sets of one seta each, 3 ventrodistal long to medium spines, one of these set subdistally; flagellum about 0.95 times as long as articles 4–5 of peduncle combined, with 8 articles.

Mandibles with weak palpar hump, right incisor with 3 teeth, left incisor with 3 humps in 2 branches, right lacinia mobilis bifid, distal branch much shorter than proximal, flabellate, broad, subbifid, proximal branch simple, blunt, with marginal denticles, left lacinia mobilis with 4 teeth plus one accessory tooth, middle teeth shortened, right rakers 8 plus 2 rudimentaries,



left rakers 5 plus one rudimentary, molars composed of bulbous protrusions, each molar with one long serrate and 2 short spines plus granulated callus, without plume, palp article 1 slightly elongate, article 2 with one medium inner apical seta and 2 other shorter inner setae, article 3 about 1.1 times as long as article 2, oblique apex with 7 and 6 spine-setae, basofacial formula = 1-1 and 0-1. Each outer lobe of lower lip with cone. Inner plate of maxilla 1 large, thin, bearing one long apical pluseta, one shorter apico-medial seta, 2 apicolateral much shorter setae, left outer plate with 10 spines, right outer plate with 11 spines, one thick on each side, palp article 2 with one apical spine, one apicolateral, 3 medial spines, and 4 submarginal setae. Inner plate of maxilla 2 slightly shorter than outer, outer scarcely broader than inner, outer with 5 apicolateral setae, inner with one medial seta. Inner plate of maxilliped with one large thick apical spine, 2 apicofacial setae, 3 medial setae, outer plate with 8 medial spines, one apicolateral seta and cusp, palp article 2 without apicolateral seta, article 2 with one apicolateral seta, medial margin of article 2 weakly setose, article 3 with 4 facial setae, one lateral seta, nail of article 4 medium, with 2 accessory setules.

Coxa 1 not expanded apically, anterior margin weakly convex, main ventral setae of coxae 1-4 = 10-11-11-10, posteriormost seta of coxae 1-4 scarcely shortened, anterior and posterior margins of coxa 4 almost parallel, posterior margin convex, posterodorsal corner rounded, posterodorsal margin V-shaped, width-length ratio of coxa 4 = 6:7. Gnathopods with elongate hands, gnathopod 2 larger than gnathopod 1 and with subcryptic wrist, width ratios on articles 5-6 of gnathopods 1-2 = 30:38 and 32:50, length ratios = 66:88 and 50:88, palmar humps large, palms strongly oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin rounded-flat, article 5 of gnathopod 2 triangular, posterior margin rounded-angular.

Pereopods 3-4 similar to each other, facial setae formula on article 4 = 6 and 5, parallel to apex, on article 5 = 5 and 5, main spine of article 5 extending to M. 90-100 on article 6, article 5 with no proximoposterior spines, spine formula of article 6 = 3 + 2 and 4 + 2 plus no middistal seta, spines especially long, medial spines tightly grouped (and inserted from lateral side, not truly medial), acclivity on inner margin of dactyls of pereopods 3-4 obsolescent, emergent setule short, almost fully immersed, mid-facial pluseta ordinary but highly antieriad. Coxae 5-7 posteroventral setule formula = 3-3-4, gills of these coxae large. Articles 4-5 of pereopods 5-6 narrow, facial spine rows sparse, facial ridge formula of article 2 on pereopods 5-7 = 0-1-1, article 2 of pereopod 5 scarcely tapering distally. Width ratios of articles 2, 4, 5, 6 of pereopod 5 = 41:23:18:10, of pereopod 6 = 64:22:15:9, of pereopod 7 = 80:16:13:7, length ratios of pereopod 5 = 69:26:36:37, of pereopod 6 = 88:48:53:55, of pereopod 7 = 100:20:25:30, article 2 of pereopod 7 much broader than in female "d" of Barnard (1960) exceeding middle of article 4, posterior margin with 7 small serrations, one

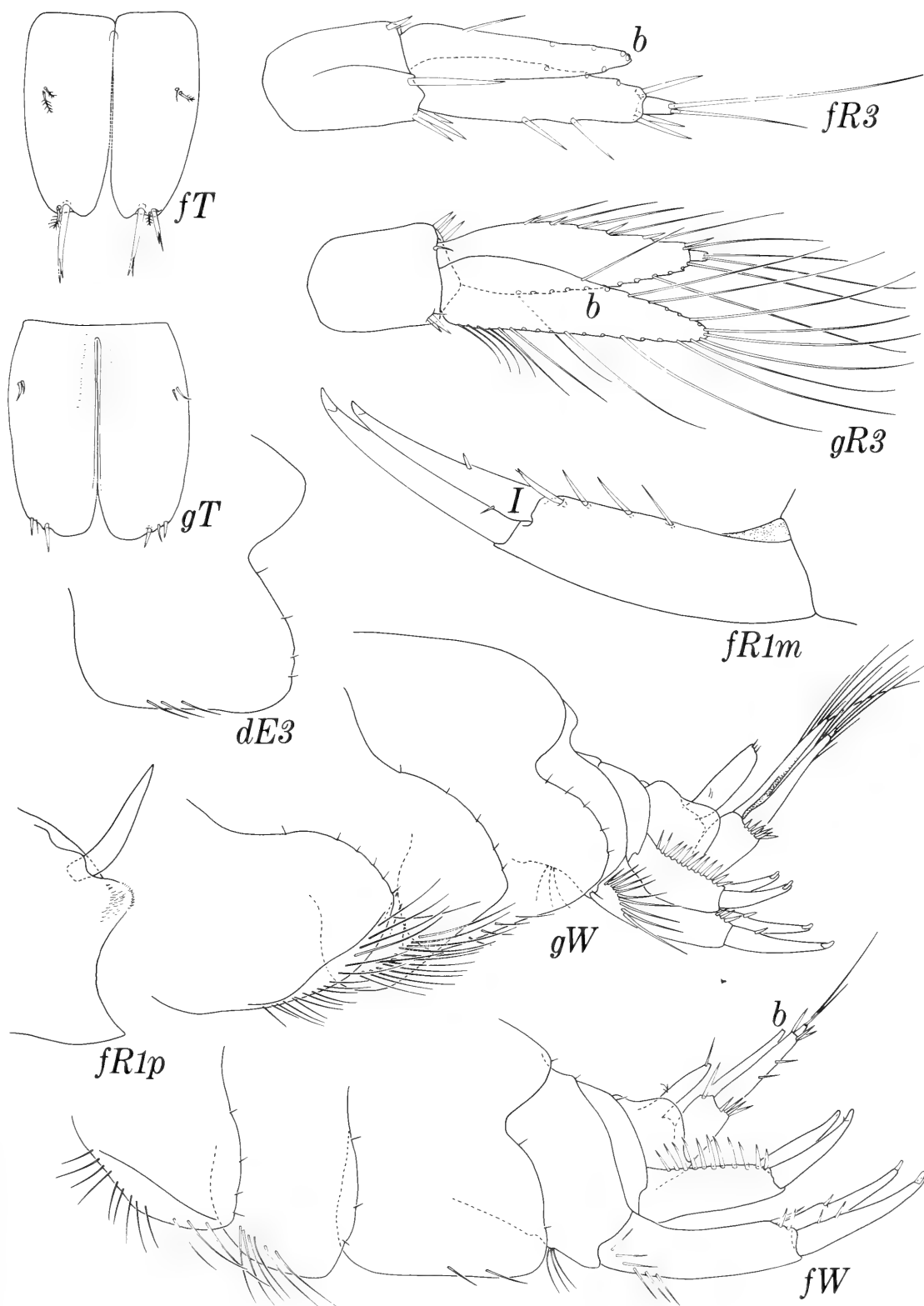


Fig. 2. *Fuegiphoxus fuegiensis*: **d** = female "d" 6.0 mm, **f** = lectotype female "f" 6.44 mm, **g** = male "g" 7.83 mm.

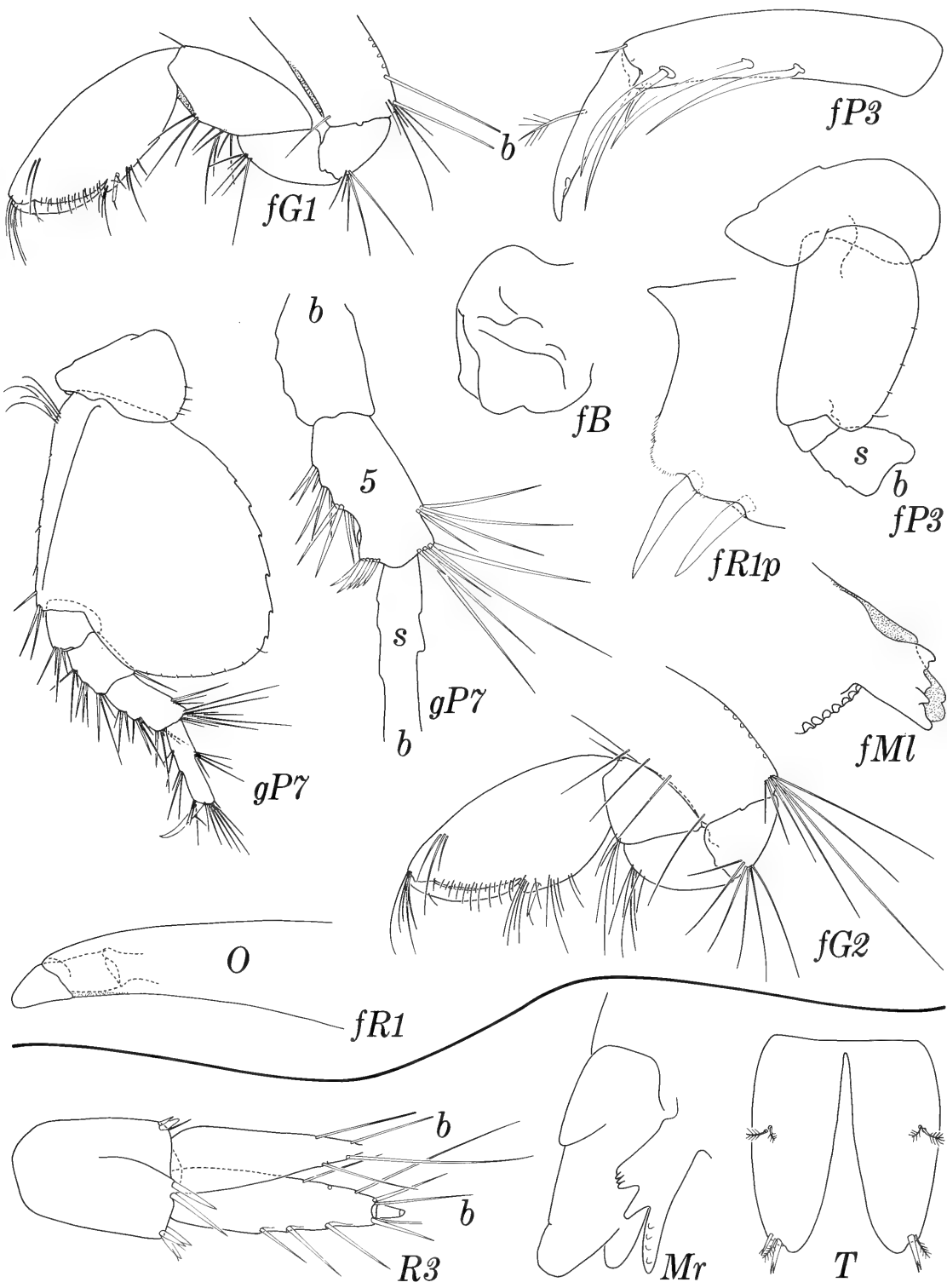


Fig. 3. Upper, *Fuegiphoxus fuegiensis*: f = lectotype female "f" 6.44 mm, g = male "g" 7.83 mm. Lower, *Fuegiphoxus inutilis*, holotype female "p" 7.80 mm.

elongate posteroventral setule, medial apex of article 6 finely to coarsely combed, bearing 7–8 digital processes.

Posteroventral corner of eipmeron 1 rounded-quadrate, posterior margin almost straight, with 4 setules, anteroventral margin with 9 medium setae, posteroventral margin with 3 long setae. Posteroventral corner of epimeron 2 rounded, posterior margin weakly convex, with 3 setules, facial setae = 6, no lateral ridge. Posteroventral corner of epimeron 3 rounded, posterior margin straight, with 2 setule notches, ventral margin with 2 setae in posterior half.

Urosomite 1 with 2 groups of 2 ventral setae, no lateral setae, articulation line complete, urosomites unprotuberant dorsally. Rami of uropods 1–2 with fused, immersed apical nails, outer ramus of uropod 1 with 1–2 dorsal spines, inner with one, rami of uropod 2 naked, peduncle of uropod 2 with 6 basofacial to ventral setae and 2–3 apicolateral spines, narrowly confined medially, with 4 marginal setae and spines, apicalmost weakly enlarged, but not displaced, plus accessory slit. Peduncle of uropod 2 with 11 dorsal spines, medially with one large apical spine, apicolateral corners of peduncles on uropods 1–2 with faint comb. Peduncle of uropod 3 with 6–7 ventral spines, dorsally with one long lateral spine, one small medial spine and setule, rami submasculine, inner extending to M. 95 on article 1 of outer ramus, apex with 2 setae, medial and lateral margins with 3 and one setae, article 2 of outer ramus short, 0.17, bearing 2 medium to long setae, medial margin of article 1 with 3 setae, lateral margin with 2 acclivities, spine formula = 1-1-2, setal formula = 0. Telson long, length-width ratio = 6:5, almost fully cleft, each apex of medium width, subtruncate, acclivity shallow, bearing short lateral setule, spine next medial longer than setule or with lateral and medial spines separated by setule, midlateral setules diverse, largest setule small.

*Description of male "g."*—Article 1 of antenna 1 with medial pubescence, article 2 with 9 ventral setae, primary flagellum with 14 articles, one calceolus each on articles 2–10, aesthetasc each on articles 2–11+, 3 aesthetascs on article 1. Facial spine formula on article 4 of antenna 2 = 3-3-3, article 5 with 3 dorsal sets of male setae and one small calceolus, ventrodistal apex with 2 thin short spines, calceolar formula of elongate flagellum = 1,2,3,4,5,6,7,9,11,13 . . . n (broken at 17).

Right mandibular rakers = 7 plus 6 rudimentaries, left = 7 plus 4 rudimentaries. Basofacial setal formula on article 3 of mandibular palp = 2-3 (opposite and offset) and 2 inner setae; left palp formula = 2-2.

Coxa 4 slightly broadened and posterodorsal corner very broadly rounded. Facial and setal spine formulas of pereopods 3–4 on article 4 = 5 + 5, on article 5 = 5 + 6, on article 6 = 4 + 2 and 5 + 2, main spine on article 5 reaching only M. 75 on article 6. Article 2 of pereopod 7 narrower than

in female, article 5 with special form of figure 3gP7, but lacking special male posterior spines found in birubiins.

Epimera 1–2 broadened, posterior margin of epimeron 3 bulbous, setal formulas: epimeron 1 anteroventral = 11, posteroventral = 6 weakly facial, epimeron 2 facial = 12–13, occasional pair vertical, epimeron 3 posterior = 5 setules, facial = 0, ventral = 4. Spine formulas of uropods: uropod 1 peduncle apicolateral = 3, basofacial = 10, uropod 2 peduncle dorsal = 12, dorsal spines on outer ramus of uropod 1 = 1–2, of uropod 2 = 0, inner ramus of uropod 1 = 1, of uropod 2 = 0, ventral spines on peduncle of uropod 3 = 9, spine formula on article 1 of outer ramus = 1–1–1–1–1–1, setal formula = 1–1–1–1–1–1. Telson slightly broadened, distal spines greatly shortened, each lobe with short basodorsal row of denticles.

*Juvenile* “j.”—Recognizable as member of this species but epimeron 3 lacking ventral setae, rami of uropod 1 lacking dorsal spines, eye very small, inner ramus of uropod 3 reaching M. 55 on article 1 of outer ramus, only seta present fully apical.

*Lectotype*.—Female “f” 6.44 mm, Swedish Museum of Natural History 6632.

*Type-locality*.—Hope Harbor, 30 April 1896, 6–10 fd (fathoms).

*Material*.—Type-locality, female “d” 6.0 mm (old length not remeasured), male “g” 7.83 mm and one other specimen. Swedish Museum of Natural History 3637, South Georgia, Boiler Bay (Kochtopfbucht), 54°22' S, 36°28' W, stones and algae, juvenile “j” 2.96 mm and one adult; 3633, Puerto Madryn, 2–5 fms, 9 November 1895 (1); 3634, Puerto Condor, 50 fms, 26 February 1896 (2 small); 3635, Punta Arenas, “Ebbestrand,” 1 December 1895 (2).

*Remarks*.—As the type-species of the genus, *fuegiensis* forms the model; and comparisons can therefore be made through the key or in remarks of following species.

*Distribution*.—Magellanic-Fuegian Archipelago, 0–91 m; South Georgia, 0–311 m; Tristan da Cunha, surface (corrected summary from Barnard, 1960).

### *Fuegiphoxus inutilis*, new species

Figs. 3, 4 (part)

*Parharpinia fuegiensis* Schellenberg, 1931:78 (in part, see text here).

*Paraphoxus fuegiensis*.—J. L. Barnard, 1960:pl. 42, figs. S, T (not most of Schellenberg, 1931).

*Description of female holotype* “p.”—Head about 18 percent of total body length, greatest width about 80 percent of length, rostrum unconstricted, broad, short, reaching middle of article 2 on antenna 1. Eyes medium, clear of pigment, ommatidia ordinary. Article 1 of peduncle on antenna 1

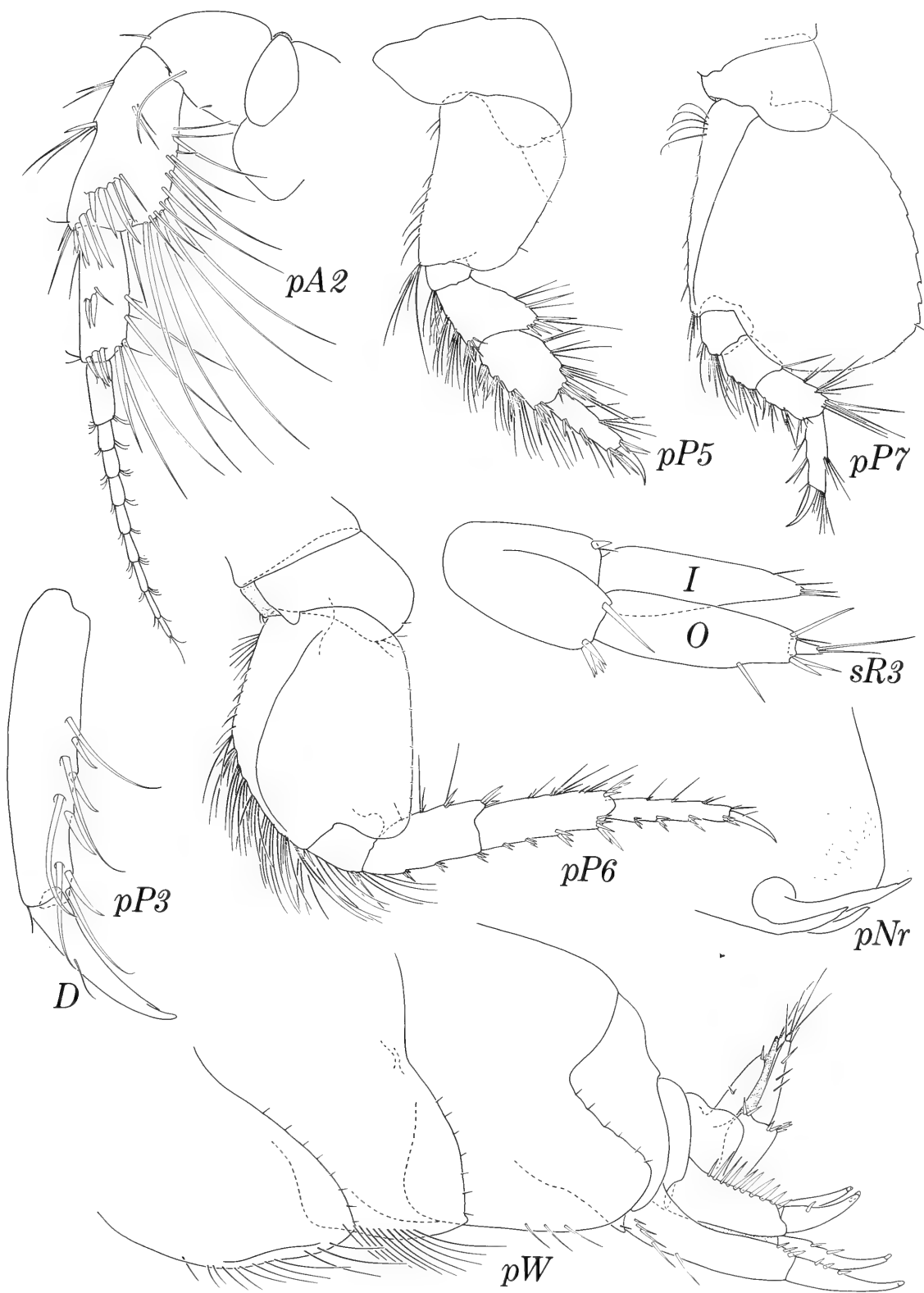


Fig. 4. *Fuegiphoxus inutilis*: p = holotype female "p" 7.80 mm; s = young male "s" 6.51 mm.

about 1.3 times as long as wide, about 2.3 times as wide as article 2, ventral margin with about 4 setules, produced dorsal apex with 3 setules, article 2 about 0.47 times as long as article 1, with apicoventral cycle of 9 setae, primary flagellum with 10 articles, about 0.9 times as long as peduncle, bearing one each short aesthetasc on articles 1–9, accessory flagellum short, with 6 articles. Antenna 2 not ensiform, spine formula of article 4 = 4-4-1, dorsal margin with 2 notches bearing 2 setae and 3 setae and one spine, ventral margin with 7 groups of 2–3 long to medium setae, one ventrodistal long spine, article 5 about 0.72 times as long as article 4, facial spine formula = 3-2, dorsal margin bearing one set of small setae, ventral margin with 5 sets of one each long setae plus setules, 3 ventrodistal long to medium spines counted in facial formula above; flagellum about as long as articles 4–5 of peduncle combined, with 9 articles.

Epistome unproduced. Mandibles with weak palpar hump, right incisor with 3 teeth, left incisor with 3 humps in 2 branches, right lacinia mobilis bifid (trifid), distal branch much shorter than proximal, broad, subbifid, distal subbifidation denticulate, proximal branch simple, pointed, with marginal denticles, left lacinia mobilis with 4 deep teeth, middle teeth not shortened, right rakers 6 plus one rudimentary, left rakers 7 plus 1–2 rudimentaries, molars composed of bulbous protrusions, each molar with one weakly serrate medium spine and 2 short spines, molars without plumes, palp article 1 greatly elongate, article 2 with 2 long to medium inner apical setae and 2 other shorter inner setae, article 3 about 1.2 times as long as article 2, oblique apex with 7 and 6 spine-setae, basofacial formula = 1-1. Each outer lobe of lower lip with one cone. Inner plate of maxilla 1 large, broad, bearing one long apical pluseta, one similar apicomedial seta, 2 apicolateral much shorter setae, outer plate with 11 spines, palp article 2 with one thin apical spine, 1–2 apicolateral, 5 medial and 4 submarginal setae. Inner plate of maxilla 2 shorter than outer, outer not broader than inner, outer with 5 lateral setae, inner with one medial seta. Inner plate of maxilliped with one large thick apical spine, 2 apicofacial setae, 4 medial setae, outer plate with 11 medial spines, 2 apicolateral setae and cusp, palp article 1 without apicolateral seta, article 2 with one group of 2 apicolateral setae, medial margin of article 2 moderately setose, article 3 with 7 facial setae, 2 lateral setae, nail of article 4 short, with 2 accessory setules.

Coxa 1 scarcely expanded apically, anterior margin convex, main ventral setae of coxae 1–4 = 13-13-14-17, posteriormost seta of coxae 1–3 slightly shortened, anterior and posterior margins of coxa 4 parallel, posterior margin convex, posterodorsal corner rounded, posterodorsal margin short, V-shaped, width-length ratio = 7:8. Gnathopods with elongate hands, gnathopod 2 larger than gnathopod 1 and with subcryptic wrist, width ratios on articles 5–6 of gnathopods 1–2 = 30:40 and 33:50, length ratios = 65:87 and 50:90, palmar humps ordinary, palms strongly oblique, article 5 of

gnathopod 1 elongate, ovate, posterior margin rounded-flat, article 5 of gnathopod 2 triangular, posterior margin rounded, angular.

Pereopods 3–4 similar to each other, facial setae formula on article 4 = 5 and 5, parallel to apex, on article 5 = 5 and 6, main spine of article 5 extending to M. 80–70 on article 6, article 5 with no proximoposterior spines, spine formula of article 6 = 4 + 5 and 4 + 5 plus no middistal seta, spines especially long, medial spines inserted from lateral side; acclivity on inner margin of dactyls of pereopods 3–4 obsolescent, emergent setule fully immersed, midfacial pluseta ordinary but highly anteriad. Coxae 5–7 posteroventral setule formula = 2-4-1. Articles 4–5 of pereopods 5–6 narrow, facial spine rows sparse, facial ridge formula of article 2 on pereopods 5–7 = 0-1-1; article 2 of pereopod 5 tapering apically. Width ratios of articles 2, 4, 5, 6 of pereopod 5 = 46:24:21:8, of pereopod 6 = 64:20:15:9, of pereopod 7 = 83:15:13:8, length ratios of pereopod 5 = 65:27:30:31, of pereopod 6 = 88:42:49:44, of pereopod 7 = 100:18:23:29, article 2 of pereopod 7 exceeding middle of article 4, posterior margin with 9–10 small serrations, one scarcely elongate posteroventral setule, medial apex of article 6 coarsely combed, bearing 7–8 digital processes.

Posteroventral corner of epimeron 1 weakly toothed, posterior margin convex, setulose, corner with setule, anteroventral margin with 8–9 long to medium setae, posteroventral margin with 3 long setae. Posteroventral corner of epimeron 2 with small sharp tooth guarded by setule sinus, posterior margin convex, setulose, facial setae = 11, none set vertically. Posteroventral corner of epimeron 3 rounded, protuberant, with setule sinus, posterior margin oblique, weakly concave, setulose, ventral margin with 3 setae near middle.

Urosomite 1 with lateral setule at base of uropod 1, no ventral setae, articulation line complete, urosomites scarcely protuberant dorsally. Rami of uropods 1–2 with fused and immersed apical nails, outer ramus of uropod 1 with 3 dorsal spines, inner with 2, outer ramus of uropod 2 with one dorsal spine, inner with no dorsomedial spines, peduncle of uropod 1 with 5 basofacial setae and 3 apicolateral narrowly confined spines, medially with 5–6 marginal spines, apicalmost weakly enlarged but not displaced, no accessory slit. Peduncle of uropod 2 with 10 dorsal spines, medially with one small apical spine, apicolateral corners of peduncles on uropods 1–2 with obsolescent comb. Peduncle of uropod 3 with 6 ventral spines, dorsally with 2 long lateral spines, one short hooked medial spine and 2 setules or spinule, rami submasculine, inner extending to M. 100 on article 1 of outer ramus, apex with [unknown] setae, medial and lateral margins with 2 and 2 setae, article 2 of outer ramus short, 0.15, bearing 2 ?long setae [broken], medial margin of article 1 with 5 setae, lateral margin with 3 or 1 acclivities, spine formula = 1-1-1-1 or 1-2, setal formula = 0-0-0-1 or 0-1 (variable on 2 sides). Telson long, length-width ratio = 13:11, almost fully cleft, each apex nar-



row, rounded, lateral acclivity broad, shallow, bearing short lateral setule, spine next medial longer than setule or with lateral and medial spines separated by setule (variable), midlateral setules diverse, largest of small size.

*Female* "s."—Eyes about as large as in *fuegiensis*.

*Male* "r."—Too young to differentiate from female.

*Juvenile* "t."—Spine formula on article 4 of antenna 2 = 0-3-3-0, on article 5 = 3 apicofacial spines. Formula on article 6 of pereopods 3-4 = 2 + 3 + 0. Epimera 1-2 with posteroventral tooth, epimeron 3 like adult but with only one ventral seta. Inner ramus of uropod 1 lacking spine, both rami of uropod 2 lacking spines.

*Holotype*.—Female "p" 7.80 mm, Swedish Museum of Natural History 3638.

*Type-locality*.—South Georgia, mouth of Cumberland Bay, 54°11'S, 36°18'W, 252-310 m, N:o 34 5/6 1902, gray clay with small (few) ("wenigen") stones, bottom temperature +1.45° [C?] [translated from label written in German, see Schellenberg, 1931:78 as *Parharpinia fuegiensis* quoted as 250-310 m and "einigen Steinen"].

*Material*.—Swedish Museum of Natural History 3636, South Georgia, outer half of May-Bay, 75 m, 54°17'S, 36°28'W, N:o 22, 14/5 1902, clay, also some algae, bottom temperature +1.5° [C?] [translated from label written in German, see Schellenberg, 1931:78 as *Parharpinia fuegiensis* quoted as "Grytviken"], female "r" 6.21 mm, young male "s" 6.51 mm, juvenile "t" 3.71 mm.

*Illustrations*: Parts not illustrated generally like those of *P. fuegiensis* herein and in J. L. Barnard (1960:pl. 42); uropod 3 of female "s" added to illustrations here to better show apex broken in the holotype.

*Remarks*.—The juvenile "t" is needed to confirm the validity of this species because the material was originally determined as *fuegiensis* by Schellenberg (1931) and again by Barnard (1960). This species differs from *F. fuegiensis*, the type-species, in the following characters: (1) Eyes of the female are only medium in size; (2) article 5 of antenna 2 has 3 apicofacial thick spines instead of one; (3) article 6 of pereopods 3-4 has more spines; (4) the epimera are broader, epimera 1-2 have a posteroventral tooth, and epimeron 3 is protrusive; (5) urosomite 1 lacks ventral setae; (6) the pleosome is larger and the urosome smaller; (7) outer ramus of uropod 3 bears a dorsal spine; (8) uropod 3 is shorter.

*Distribution*.—South Georgia, 75-250 m (confirmed minimum range).

### *Fuegiphoxus abjectus*, new species

Figs. 5, 6

*Description of holotype* "h" male.—Head about 18 percent of total body length, greatest width about 75 percent of length, rostrum unstricted,

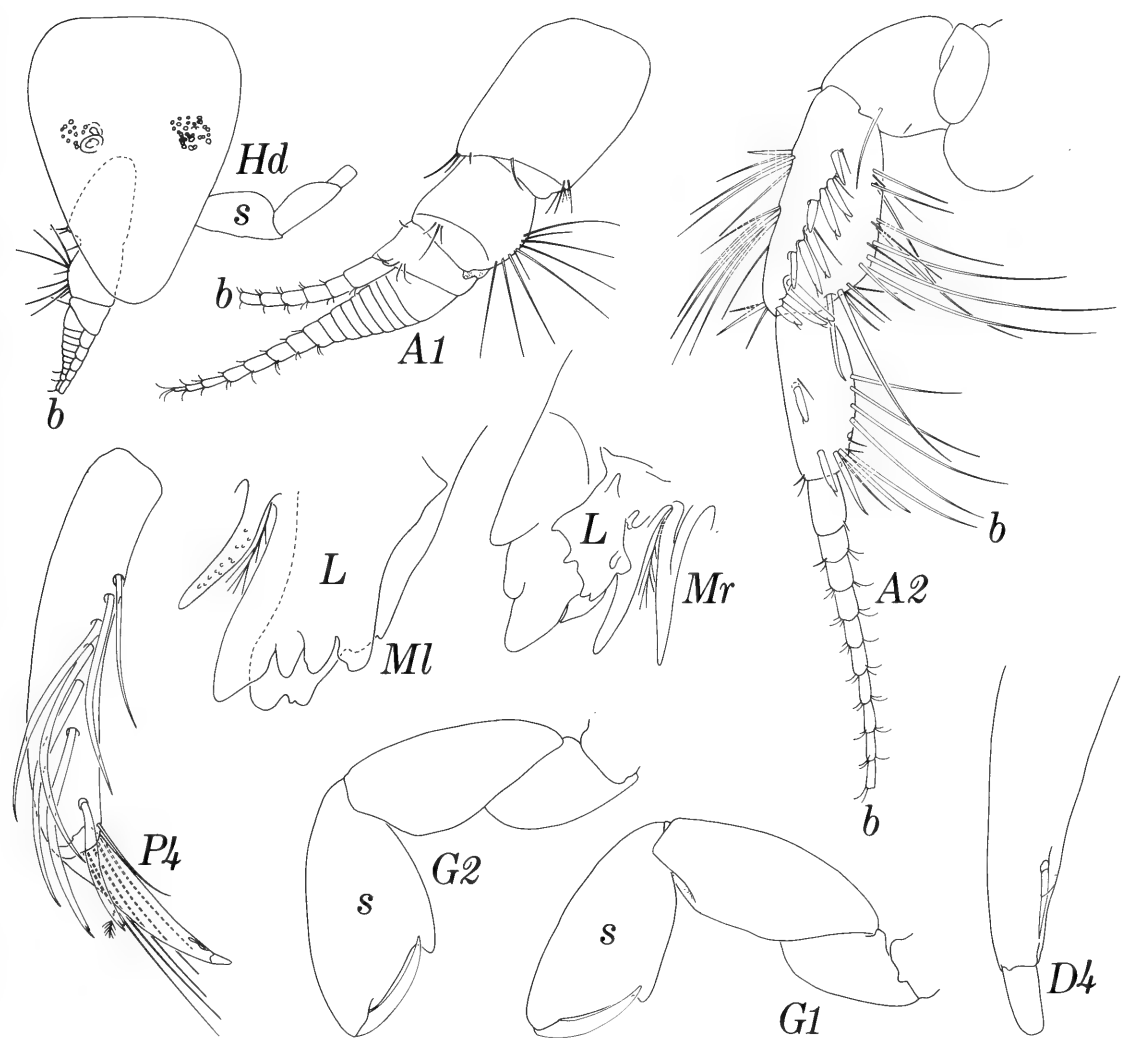


Fig. 5. *Fuegiphoxus abjectus*: holotype male "h" 10.55 mm.

broad, of ordinary length, tapering evenly, reaching apex of article 2 on antenna 1. Eyes small or absent or diffuse. Article 1 of peduncle on antenna 1 about 1.4 times as long as wide, about 1.3 times as wide as article 2, ventral margin with about 6 setules, weakly produced dorsal apex with 2–3 setules, article 2 about 0.55 times as long as article 1, with ventral row of 9 setae (broken), primary flagellum with 16 articles, about 0.8 times as long as peduncle, bearing one each tiny aesthetasc on articles 7–15, basal third of flagellum swollen, no medial fuzz on antenna 1, accessory flagellum with ? articles [broken]. Antenna 2 not ensiform; spine formula of article 4 = 3-3-3-1, dorsal margin with 2 notches bearing 6 and 4 (distal to proximal) setae and one spine (proximal), ventral margin with 8 groups of 1–3 long to short setae, one ventrodistal long spine, article 5 about 0.75 times as long as article 4, facial spine formula = 1, dorsal margin bearing one set of small

distal setae, ventral margin with 6 sets of one long seta each, 3 ventrodistal short to medium spines, one of these strongly facial, flagellum [broken after article 10]. Epistome not produced. Mandibles with weak palpar hump, right incisor with 4 teeth!, left incisor with mainly 3 humps in 2 branches, right lacinia mobilis bifid, distal branch much shorter than proximal, flabellate, denticulate, proximal branch simple, pointed, left lacinia mobilis with 4 teeth, middle teeth slightly shortened, right rakers 9 plus 3 rudimentaries, left rakers 10 plus 2 rudimentaries, molars composed of bulbous protrusions, each with one very long serrate and 2 medium spines, molar without plume, palp thin but very elongate, article 1 short, article 2 with 1 long to medium inner apical seta and 2 other short inner setae, article 3 about 1.3 times as long as article 2, oblique apex with 9 thin spine-setae, basofacial formula = 0-2. Each outer lobe of lower lip with one cone. Inner plate of maxilla 1 especially large, thin apically, broad basally, bearing one medium subapical pluseta, one longer similar facial seta, 2 apicolateral much shorter setae, outer plate with 11 spines, palp article 2 with 2 apical, 4 medial spines and 5 submarginal setae. Plates of maxilla 2 extending subequally, outer scarcely broader than inner, outer with 4 apicolateral setae, inner with one medial seta. Inner plate of maxilliped with one large thick apical spine, 3 apicofacial setae, 4 medial setae, outer plate with 11 medial spines, 2 apicolateral setae and 2 cusps, palp article 1 with one apicolateral seta, article 2 with one group of 3 apicolateral setae, medial margin of article 2 moderately setose, article 3 with 4 facial setae, 2 lateral setae, nail of article 4 medium, with 2 accessory setules.

Coxa 1 not expanded apically, anterior margin weakly convex, main ventral setae of coxae 1-4 = 17-12-12-14, only posteriormost seta of coxa 1 strongly shortened, anterior and posterior margins of coxa 4 slightly divergent, posterior margin convex, posterodorsal corner rounded, posterodorsal margin ordinary, concave, width-length ratio = 5:6. Gnathopods generally ordinary, gnathopod 2 scarcely longer than gnathopod 1, width ratios on articles 5-6 of gnathopods 1-2 = 27:32 and 27:34, length ratios = 65:61 and 61:62, palmar humps ordinary, palms strongly oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin rounded-flat long, article 5 of gnathopod 2 elongate, ovate, posterior margin rounded.

Pereopod 4 slightly stouter than pereopod 3 especially on article 4, facial setae formula on article 4 = 8 and 6, parallel to apex, on article 5 = 9 and 8, main spine of article 5 extending to M. 100-90 on article 6, article 5 with no proximoposterior spines, spine formula of article 6 = 6 + 5 and 7 + 6 but no middistal seta, medial members = clump of thin apical setae, spines especially long, acclivity on inner margin of dactyls of pereopods 3-4 represented by slit, emergent setule short, midfacial pluseta anteriad, short. Coxae 5-7 posteroventral seta formula = 6-5-1. Articles 4-5 of pereopods 5-6 narrow, facial spine rows sparse, facial ridge formula of article 2 on

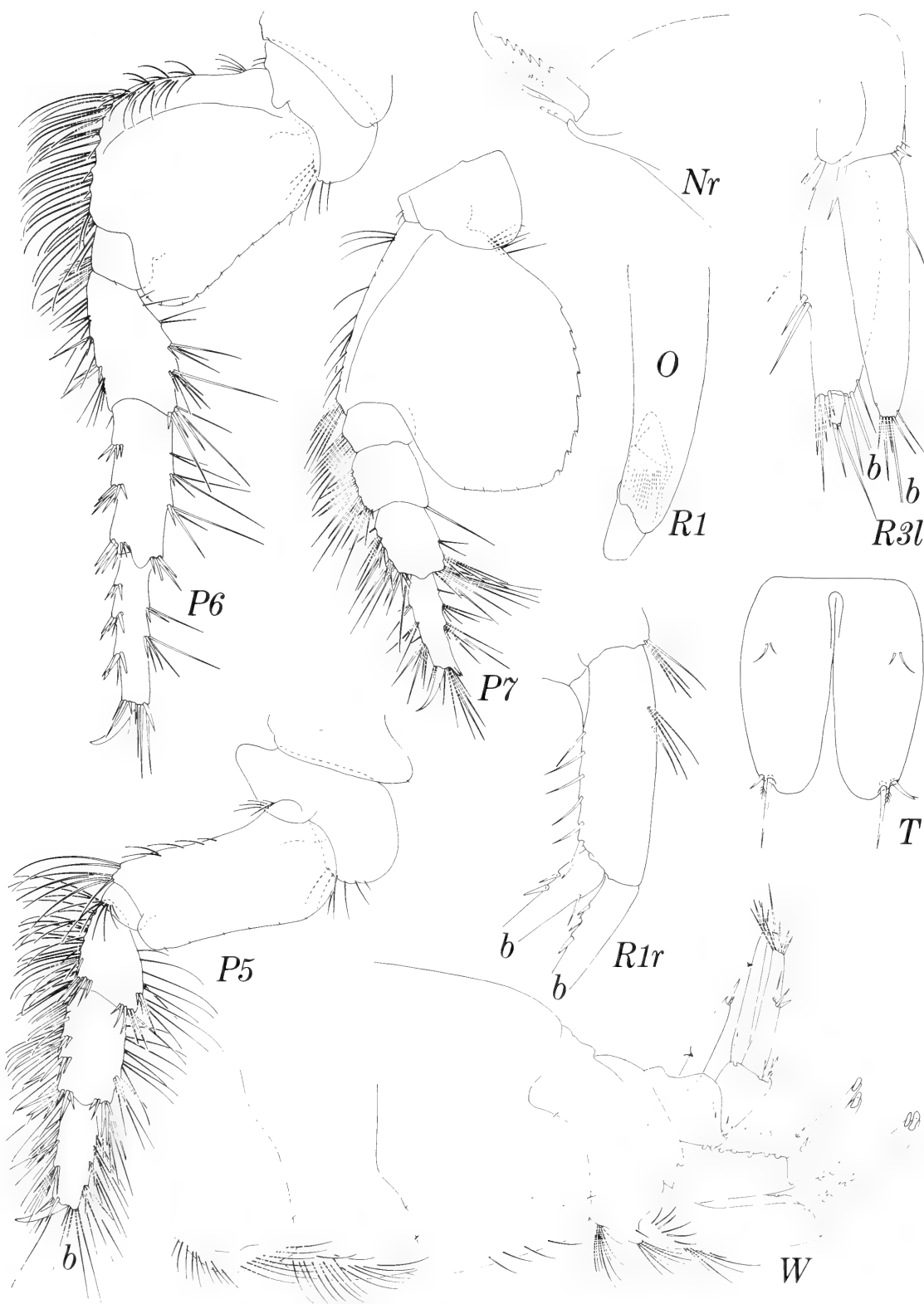


Fig. 6. *Fuegiphoxus abjectus*: holotype male "h" 10.55 mm; dotted spine on R3 shown for same member on right side of animal.

pereopods 5–7 = 0-1-1. Width ratios of articles 2, 4, 5, 6 of pereopod 5 = 40:25:25:15, of pereopod 6 = 72:29:23:14, of pereopod 7 = 90:23:20:12, length ratios of pereopod 5 = 78:32:42:41, of pereopod 6 = 95:48:60:58, of pereopod 7 = 100:26:28:39, article 2 of pereopod 7 exceeding middle of article 4, posterior margin with 7 medium serrations and several long posterodorsal setae (very unusual), setae of articles 3–4 very thick and stiff, medial apex of article 6 scarcely combed, bearing 9 digital processes.

Posteroventral corner of epimeron 1 quadrate, posterior margin straight, with setule, anteroventral margin with 10 medium setae, posteroventral face with horizontal row of 7 long setae. Posteroventral corner of epimeron 2 rounded-quadrate and weakly protuberant, posterior margin weakly convex, with 2 setules, facial setae = 15, occasionally middle pairs set vertically. Posteroventral corner of epimeron 3 rounded, overall protuberant but posterior margin weakly convex, with 2 setule notches, ventral margin with 4 setae mainly in posterior half.

Urosomite 1 with lateral setule at base of uropod 1, brush of setae ventral to uropod 1 and brush of midventral setae, articulation line complete, urosomites unprotuberant dorsally. Rami of uropods 1–2 with articulate but tightly fixed apical nails, outer ramus of uropod 1 with 3 dorsal spines, inner with 2, outer ramus of uropod 2 with one dorsal spine, inner with one dorsomedial spine, peduncle of uropod 1 with 7 basofacial and ventral cluster of 5 setae, one apicolateral spine, medially with 6 marginal setae and spines, apicalmost enlarged but not displaced. Peduncle of uropod 2 with 7–8 dorsal spines, basalmost thin and elongate, medially with one medium apical spine, apicolateral corners of peduncles on uropods 1–2 with very weak comb. Peduncle of uropod 3 with 6 ventral spines, dorsally with one lateral spine, one medial spine and 2 setules, rami submasculine, inner extending to M. 100+ on article 1 of outer ramus, apex with 4 setae, medial and lateral margins with 2 and one setae, article 2 of outer ramus short, 0.16, bearing 2 short to medium setae, apicomedial margin of article 1 with 3 setae, lateral margin with 1–2 acclivities, spine formula = 0-2-5 or 0-4-4, setal formula = 0-0-1 or 1-0-1. Telson long, length-width ratio = 33:28, almost fully cleft, each apex of medium width, rounded, lateral acclivity broad, shallow, with short lateral and long medial spines separated by short setule, midlateral setules diverse, largest of small size, denticles absent.

*Notes.*—Male unusual: antenna 2 not elongate, uropod 3 not fully developed, denticles on telson absent; therefore male possibly youthful.

*Holotype.*—Swedish Museum of Natural History 3631, male “h” 10.55 mm. Unique.

*Type-locality.*—Bahia Inutil, 23 January 1896, 20–30 fd.

*Remarks.*—This specimen was formerly called *Parharpinia fuegiensis* by Schellenberg, then *Paraphoxus fuegiensis* by J. L. Barnard (1960) and was

considered to be a female but now is thought to be a male of character similar to that of *Elpeddo kaikai* Barnard and Drummond (1978:119).

The remarkable antenna 1 of this unique male links *Fuegiphoxus* with the Australian *Elpeddo* as noted in remarks after the description of *Fuegiphoxus* above. In fact, *abjectus* has more strong characters of difference from its sympatriots *fuegiensis* and *inutilus* in South America than from *Elpeddo* but the characters noted earlier in this paper seem to be more important to distinguish genera than to invoke distinctions simply by counting the number of unevaluated differences among taxa.

*Fuegiphoxus abjectus* differs from both *F. inutilus* and *F. fuegiensis* in: (1) the formula, spacing and thickness of the spines on article 4 of antenna 2; (2) the odd male antenna 1; (3) the short article 1 of the mandibular palp; (4) the scarcely enlarged gnathopod 2; (5) the odd setal clump on article 6 of pereopods 3–4; (6) the shape of epimeron 3; and (7) the setal brush on the apex of urosomite 1.

#### *Fuegiphoxus? uncinatus* (Chevreux)

*Pontharpinia uncinata* Chevreux, 1912:4; 1913:100–104, figs. 10–12.

*Paraphoxus uncinatus*.—J. L. Barnard, 1960:283.

This species is provisionally assigned to *Fuegiphoxus* but many characters need confirmation, for example: spine formulas on antenna 2, laciniae mobiles, mandibular palp, maxillipedal spine counts and dactyl formations, setal formulas of epimera 1–2 and urosomite 1, spine formulas on apices of rami on uropods 1–2, and medial margins of peduncles.

For the moment, the species is distinguished from others in its genus by the long thin posteroventral tooth of epimeron 3.

*Distribution*.—Antarctica, Port Lockroy, Chenal de Roosen, 60–70 m.

#### *Phoxorgia*, new genus

*Diagnosis*.—Eyes present. Flagella of antennae 1–2 unreduced in female, article 2 of antenna 1 shortened, ventral setae confined apically; article 1 of antenna 2 not ensiform, article 3 with 3 lateral setae, facial spines on article 4 in 2 or more rows, article 5 ordinary in size. Right mandibular incisor with 3 teeth, molar not triturative, small, pillow shaped, bearing 4 or more splayed spines, bearing pubescence, palpar hump moderate. Palp of maxilla 1 biarticulate, inner plate with 4 setae; setation of maxilla 2 ordinary. Inner plate of maxilliped ordinary, apex of palp weakly protuberant, dactyl elongate, apical nail weakly distinct, medium.

Gnathopods ordinary, small, similar, wrists elongate, unlobed, without eusirid attachment, palms transverse, hands bell-shaped, poorly setose an-

teriorly. Article 2 of pereopod 5 of broad form, scarcely tapering apically, articles 4–5 of pereopods 5–6 narrow, article 2 not setose posteriorly, pereopod 7 ordinary, article 2 naked ventrally, article 3 ordinary, dactyl normal.

Peduncle of uropod 1 normally elongate, without apical spike, with displaced apicomedial spine, uropods 1–2 without comb, inner ramus of uropod 1 with one row of marginal spines, inner ramus of uropod 2 more or less continuously spinose to apex (with one accessory nail), apical nails well developed and that on inner ramus of uropod 1 flexibly articulate, inner ramus of uropod 2 normal (not fused). Uropod 3 ordinary, bearing article 2 of outer ramus, carrying 2 short apical setae. Telson ordinary, each lobe with 2 apical spines and attendant setule, without other special seta. Epimera 1–2 bearing sparse short posterior setules, without midfacial setae above ventral facial ridge, epimeron 3 ordinary and bearing 3 or more long setae in adult. Urosomite 1 without large lateral armament, bearing one or more large bundles of ventral setae, urosomite 3 without hook or special process.

*Description*.—Rostrum fully developed but weakly constricted. Pubescence and calceoli on male antennae [unknown]. Prebuccal parts ordinary. Right lacinia mobilis bifid or multitoothed, article 1 of mandibular palp short, palp thin, apex of article 3 oblique, article 2 without outer setae. Lower lip bearing cones. Outer plate of maxilla 1 with 11 spines, one spine especially thickened. Inner plates of maxillipeds with 3 main spines, ordinarily setose. Coxae 2–4 without special anterodorsal humps. Posterior spines on article 6 of pereopods 3–4 thick and stiff, midapical seta present; article 2 of pereopod 7 without facial setae. Peduncle of uropod 1 with dorsolateral spines widely spread, medial spines widely spread; peduncle of uropod 2 with only one medial spine confined apically; peduncle of uropod 3 lacking extra subapical setae or spines. Telson with one or more apical spines plus one disjunct subapical spine on each lobe plus attendant setules.

*Etymology*.—From "*Phoxocephalus*," the type-genus of the family and "orgyia," Greek for fathom, modified so as to simplify. Feminine.

*Type-species*.—*Parharpinia sinuata* K. H. Barnard, 1932.

*Composition*.—Unique.

*Relationship*.—This genus is very close to *Parharpinia* Stebbing from Australia (see Barnard and Drummond, 1978). It resembles that genus in broad generalities of uropod 1, especially the diverse pattern of spination, and in the presence of 3 main spines on the inner plate of the maxilliped. There are many other similarities such as extreme antennal spination, slight taper to article 2 of pereopod 5 (strong in *Parharpinia*, barely discernible in *Phoxorgia*), presence of at least remnants of accessory apical spination on uropods 1–2, extra telsonic spination (dorsal in *Parharpinia*, marginal in *Phoxorgia*) and generalities of head, mandible, and uropod 3.

*Phoxorgia* differs from *Parharpinia* in the apical shift of setae on article

2 of antenna 1 (characteristic of juveniles in *Parharpinia*), the lack of true dorsal spines on the telson, the absence of ventral setae on article 2 of pereopod 7, and the poor posterior setation on epimera 1–2. These may ultimately not be adequate to segregate *Phoxorgia* but for the moment can be correlated with geography.

*Phoxorgia* appears to be a very good plesiomorph both to *Parharpinia* and *Metharpinia*, the latter an American genus already revised by J. L. Barnard (1980). *Phoxorgia* is plesiomorphic to both genera because of the absence of dorsal telsonic spines, plesiomorphic to *Parharpinia* in addition because of almost normal pereopod 5, and poor epimeral and pereopod 7 setation. It is plesiomorphic to *Metharpinia* which differs from *Phoxorgia* in the strongly reduced rostrum, widely spread ventral setation on article 2 of antenna 1, reduction of main spination on inner plate of maxilliped (from 3 down to 2 or 1), and the loss of true apical nails, only the accessories remaining. The connection to *Microphoxus* through *Metharpinia* can be determined in Barnard (1980).

*Phoxorgia* shares with *Fuegiphoxus* the odd position of setae on article 2 of antenna 1 but otherwise differs in numerous characters from *Fuegiphoxus*, as follows: (1) stronger spination on article 4 of antenna 2; (2) stronger and more even spination on mandibular molars; (3) presence of 3 (not 1) spines on inner plate of maxilliped; (4) displaced spine of uropod 1; and (5) well developed apical and accessory apical spines on the rami of uropods 1–2. *Fuegiphoxus* therefore appears to be apomorphic to *Phoxorgia* and is actually in the Brolginae.

*Phoxorgia sinuata* is very close to *Foxiphalus* but differs from an undescribed species (here called species S which will be described in a later paper) in the following ways: (1) slightly constricted and highly flattened head; (2) shortened article 2 of antenna 1 with the setae shifted apicad; (3) presence of more than 2 facial setae on article 3 of antenna 2; (4) flabellate and subbifid distal branch of the right lacinia mobilis; (5) presence of more than one apical spine on the inner plate of the maxillipeds; and (6) the presence of an accessory apical nail on the inner ramus of uropod 1.

*Phoxorgia sinuata* (K. H. Barnard)

Fig. 7

*Parharpinia villosa*, Schellenberg, 1931:75–78, fig. 39 (not Haswell, 1879); 1935:232.

*Parharpinia sinuata* K. H. Barnard, 1932:103–104, fig. 52.

*Paraphoxus sinuatus*, J. L. Barnard, 1958:147–148; 1960:278–282, pl. 45.

*Description of female* “v.”—Head very flat, about 22 percent of total body length, greatest width about 72 percent of length, rostrum slightly constricted near eyes, then continuing broad but tapering, short, reaching



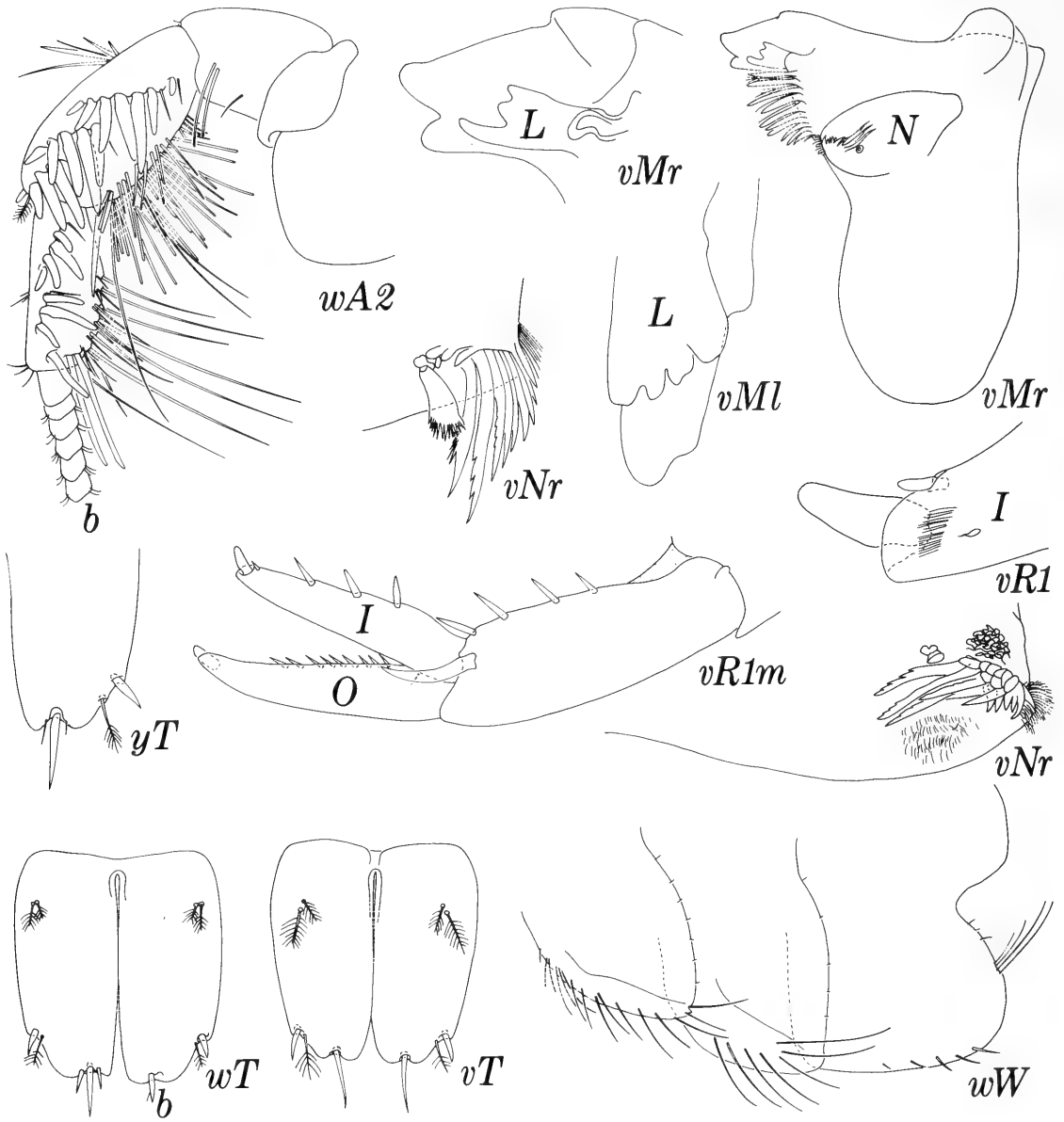


Fig. 7. *Phoxorgia sinuata*: v = female "v" 10.5 mm; w = female "w" 18.1 mm; y = male "y" 10.3 mm.

apex of article 2 on antenna 1. Eyes medium, clear of pigment, ommatidia ordinary. Article 1 of peduncle on antenna 1 about 1.4 times as long as wide, about twice as wide as article 2, ventral margin with about 14+ setules, weakly produced dorsal apex with 2 setules, article 2 about 0.5 times as long as article 1, with apicoventral cycle of 9 setae and 8+ lateral setae at apex, primary flagellum with 15 articles, about 1.2 times as long as peduncle, bearing one short aesthetasc each on articles 8–12, accessory flagellum with 11 articles. Antenna 2 not ensiform though article 1 very large, article 3 with 3 lateral setae, spine formula of article 4 = 1-3-6-5-1 or 1-3-5-5-1, dorsal

margin with weak notch bearing 3 setae, and 2 spines, ventral margin with 5 groups of 3–5 long to medium setae, one ventrodistal long spine, article 5 about 0.8 times as long as article 4, facial spine formula = 3-4, dorsal margin bearing 2 sets of small setae, ventral margin with 4 sets of 1–2 long to medium setae, 3 ventrodistal long to medium spines, one of these strongly facial; flagellum about 1.5 times as long as articles 4–5 of peduncle combined, with 16 articles.

Epistome bulbous anteriorly, fused with upper lip. Mandibles with medium palpar hump, right incisor with 3 teeth, left incisor with 3 humps in 2 branches, right lacinia mobilis bifid, distal branch much shorter than proximal, distal branch broad, subbifid, proximal branch simple, blunt, left lacinia mobilis with 4 teeth, right rakers 10 plus one rudimentary, left rakers 9+, molars composed of elongate bulbous protrusions, right molar with 6 long spines, 6 short teeth, plus one ragged spine weakly disjunct, left molar with 6 long spines, plus 4 short teeth plus ragged spine weakly disjunct, each molar with plume, palp article 1 short, article 2 with one medium inner apical seta and 3 other shorter inner setae and one outer seta, article 3 about 1.1 times as long as article 2, oblique apex with 9 spine-setae, basofacial formula = 1-2. Each outer lobe of lower lip with one cone. Inner plate of maxilla 1 ordinary, bearing one long apical pluseta, one similar apicomedial seta, 2 apicolateral much shorter setae, outer plate with 11 spines, palp article 2 with 2 apical setal-spines, 2 medial setal spines, one apicolateral and 4 medial marginal setae. Inner plates of maxilla 2 scarcely shorter than outer, outer not broader than inner, outer with 6 apicolateral setae, inner with 2 medial setae. Inner plate of maxilliped with 3 large thick apical spines, 2 apicofacial setae, 6 medial setae, outer plate with 11 medial spines, 6 apicolateral setae, palp article 1 without apicolateral seta, article 2 with one apicolateral seta, medial margin of article 2 moderately to weakly setose, article 3 with 10 slightly strewn facial setae, 3 lateral setae in clump, nail of article 4 mostly fused but short and internally visible, with 2 accessory setules.

Coxa 1 expanded apically, anterior margin weakly convex or sinuous, main ventral setae of coxae 1–4 = 7-6-6-4, posteriormost seta of coxae 1–3 very short, anterior and posterior margins of coxa 4 weakly divergent, posterior margin almost straight, posterodorsal corner rounded, posterodorsal margin, ordinary, concave, width-length ratio of coxa 4 = 14:17. Gnathopods generally ordinary, width ratios on articles 5–6 of gnathopods 1–2 = 22:33 and 25:34, length ratios = 66:60 and 60:58, palmar humps ordinary, palms weakly oblique, article 5 of gnathopod 1 elongate, ovate, posterior margin flat, long, article 5 of gnathopod 2 ovate, posterior margin rounded, short.

Pereopods 3–4 similar to each other, facial setae formula on article 4 = 4 and 3, parallel to apex, on article 5 = 4 and 5, main spine of article 5

extending to M. 100 on article 6, article 5 with 3 and 2 proximoposterior spines, spine formula of article 6 = 4 + 5 and 4 + 5 plus strong middistal seta (like *Foxiphalus*, not *Fuegiphoxus*), some spines long, acclivity on inner margin of dactyls of pereopods 3–4 weak, subsharp, produced as tooth, emergent setule almost fully immersed, midfacial pluseta ordinary but highly anteriad. Coxae 5–7 posteroventral seta formula = 3-3-7. Articles 4–5 of pereopods 5–6 narrow, facial spine rows sparse, facial ridge formula of article 2 on pereopods 5–7 = 0-1-1. Width ratios of articles 2, 4, 5, 6 of pereopod 5 = 48:30:26:15, of pereopod 6 = 78:35:28:15, of pereopod 7 = 96:23:22:12, length ratios of pereopod 5 = 83:36:41:52, of pereopod 6 = 97:67:59:81, of pereopod 7 = 100:30:32:43. Article 2 of pereopod 7 not reaching middle of article 4, posterior margin with 10 small serrations, medial apex of article 6 finely combed, bearing 6 digital processes.

Posteroventral corner of epimeron 1 quadrate, posterior margin straight, with 2 setules, corner with long seta, anteroventral margin with 6 short to medium setae, ventral margin with one long seta. Epimera 1–2 with lateral ridge. Posteroventral corner of epimeron 2 rounded-quadrate, posterior margin straight, with 2 setules, facial setae = 6, posteriormost pair set vertically and positioned above tangent of others, posteroventral corner of epimeron 3 broadly rounded, then with 4 crowded setae at ventral end of straight posterior margin, above with one setule notch, ventral margin with 4 short setal spines widely spread.

Urosomite 1 with lateral spinule at base of uropod 1 and midventral setal brush, articulation line almost complete, urosomites unprotuberant dorsally. Rami of uropods 1–2 with articulate but tightly fixed apical nails, except inner ramus of uropod 1 with flexible nail, plus accessory nail, spines on outer rami small and numerous and extending almost to apex, outer ramus of uropod 1 with 11 dorsal spines, inner with 3 large spines, outer ramus of uropod 2 with 6 dorsal spines, inner with 2 large dorsomedial spines, peduncle of uropod 1 with 3 widely spread basofacial spinules, 9 packed apicolateral spines, medially with 4 thin marginal spines and apical displaced enlarged spine, peduncle of uropod 2 with 8 dorsal spines, basalmost short, medially with one medium apical spine, apicolateral corners of peduncles on uropods 1–2 without comb. Peduncle of uropod 3 with 8 ventral spines, dorsally with one lateral spine, one medial spine, rami submasculine, inner extending to M. 75 on article 1 of outer ramus, apex with 2 setae, medial and lateral margins with 6 and one setae, article 2 of outer ramus ordinary, 0.23, bearing 2 short to medium setae, medial margin of article 1 with 3 setae, lateral margin with 4 acclivities, spine formula = 2-2-2-2-2, setal formula = 0-0-0-0-1. Telson ordinary, length-width ratio = almost 1:1, almost fully cleft, each apex wide, rounded, but incised apically, lateral acclivity narrow, weak, bearing short lateral spine, setule next medial of length equal

to spine, medial spine in terminal incision, midlateral setules diverse, larger of medium size.

*Male "y" (not fully terminal).*—Eyes not enlarged. Article 1 of antenna 1 with 12 ventral setules, article 2 with 8 anteroventral setae and 5 apicolateral setae, primary flagellum with 17 articles, accessory with 11, calceoli absent, aesthetascs weakly developed, pubescence on antennae absent. Facial spine formula on article 4 of antenna 2 = 1-3-5-5-1, on article 5 = 3-4, with no dorsal sets of male setae and calceoli, ventrodiscal apex with 3 thick spines; flagellum weakly proliferate, with 18 articles. Basofacial setal formula of article 3 on mandibular palp = 1-3 or 1-2. Article 2 of only pereopod 7 slightly narrower than in female. Epimera 1-3 not broadened, posterior margin of epimeron 3 not shortened, setal formulas: epimeron 1 anteroventral = 5, facioventral = 3, then large gap to posterior corner = 1, epimeron 2 facial = 7 (2 posterior = vertical), epimeron 3 posterior = 4, ventral = 3. Spine formulas of uropods: uropod 1 peduncle apicolateral = 9, basofacial = 2, uropod 2 peduncle dorsal = 9, dorsal spines on outer ramus of uropod 1 = 12, of uropod 2 = 6, inner ramus of uropod 1 = 4 + 1 accessory nail, of uropod 2 = 2, ventral spines on peduncle of uropod 3 = 7, inner ramus extending to M. 90 on article 1 of outer ramus, well setose, spine formula on article 1 of outer ramus = 1-2-2-2-2, setal formula = 0-0-0-0-1; telson like female, distal spines not shortened. Apical spine guarded by 2 setules (figured), no denticle rows.

*Female "w" giant.*—See illustration of antenna 2 noting flagellum slightly proliferate as in males. Epimera 1-3 illustrated, noting epimeron 1 posteroventral corner slightly produced into 2 cusps. Armament formulas, uropod 1 basofacial peduncle = 4 in long string, peduncle apicolateral = 15 (covering almost half of margin), outer ramus = 17, inner ramus = 5 + one accessory apical nail; uropod 2 peduncle dorsal = 14, outer ramus = 11, inner ramus = 3; uropod 3 peduncle ventral = 9, article 1 outer ramus spines = 1-2-2-2-2-2, setae = 0-0-0-0-0-1, medial margin of article 1 on outer ramus on both margins of inner ramus strongly setose, article 2 on outer ramus = 0.14. Telson illustrated.

*Juvenile "k."*—Ventrodiscal setae of article 2 on antenna 1 = 4. Setae on article 3 of antenna 2 = one long, one short only, spine formula on article 4 = 1-3-4-3, on article 5 = 2 only. Right lacinia mobilis similar to adult, right molar with 7 main spines and one disjunct, basal setal formula on palp article 3 = 0-0. Spine formula on inner plate of maxilliped = 3 (like adult). Epimeron 1 with 3 anteroventral setae, no others. Epimeron 2 with 4 facial setae, posterior pair of facials slightly disjunct and obliquely set. Epimeron 3 with one ventral and 2 posterior setae. Spine formulas: uropod 1 peduncle apicolateral = 3, outer ramus = 4, inner ramus = 2, on latter accessory nail rudimentary, only socket truly present; uropod 3 dorsal peduncle = 3, outer

ramus = 2, inner ramus = 1; uropod 3 outer ramus article 1 spines = 1-2-2, setae = 0-0-0, article 2 about 0.45!!, inner ramus extending to M. 55 on article 1 of outer ramus, with only one apical seta.

*Material*.—Swedish Museum of Natural History 2722, Bahia Inutil, 20–30 Fd., 23/1/96 (11 specimens, including male “y” 10.3 mm and female “v” 10.5 mm); 3640, W. Feuerland, 54°43’S, 64°08’W, 6/1/02, 36 m, pebbles and gravel, senile female “w” 18.1 mm; 3631, juvenile “k” 5.18 mm; 2728, Bahia Inutil, 11–5 fms, 23/1/96 (1); 3639, Punta Arenas, 7–8 fms, 4/12/95 (juvenile); 2741, Isla Nueva, 30 fms, 7/2/96 (15); 591, Valparaiso, 6–8 fms, several but others in sample not this genus. Smithsonian Institution: *Albatross* 2776, Straits of Magellan, 52°41’00”S, 69°55’30”W, 21 fms, 18 January 1888, water surface temperature 51 F (1).

*Distribution*.—Valparaiso, Chile through Magellanic Archipelago to South Georgia, 4–159 m.

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## A NEW SPECIES OF PIKEBLENNY (PISCES: CHAENOPSIDAE: *CHAENOPSIS*) FROM THE WESTERN ATLANTIC

Philip A. Hastings and Robert L. Shipp

**Abstract.**—*Chaenopsis roseola* is described from the middle shelf region of the northeastern Gulf of Mexico. It is distinguished from its closest known congener in the western Atlantic, *C. stephensi*, on the basis of pigmentation pattern, morphometrics, and palatine tooth pattern. The relationship of the forms is discussed, but the status of a specimen from off Yucatan, previously assigned to *C. stephensi*, is unresolved. The habitat of *C. roseola*, as observed from a research submersible, consists of “windrows” of shell rubble.

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The blennioid genus *Chaenopsis* (Pisces: Chaenopsidae) has been divided into two species groups based on body length, number of fin-ray elements, and number of body blotches or bands (Böhlke, 1957b). In the western Atlantic *Chaenopsis ocellata*, *C. resh*, and *C. limbaughii* compose the long-bodied, high-count (or *ocellata*) group while the short-bodied (or *coheni*) group has been represented by only *C. stephensi* Robins and Randall (1965).

Recent baseline studies of fishes of the continental shelf of the northeastern Gulf of Mexico using semi-balloon trawls with fine mesh (9.5 mm) liners and Capetown dredges with inner baskets of 6.4 mm mesh have been especially productive in capturing previously unknown or poorly known small, cryptic fish species. Among these is a new species of short-bodied *Chaenopsis* which is herein described.

### Methods and Materials

Methods of taking measurements follow Hubbs and Lagler (1964) except for eye diameter for which we measured the pigmented eye as described by Böhlke (1957a). All measurements from snout include the upper lip. Interorbit equals least bony interorbital width. Pectoral fin length equals length of the longest ray. MP index equals  $10 \times$  distance between mandibular pores 3 and 2 divided by the distance between mandibular pores 1 and 2 (Robins and Randall, 1965). All measurements were made with dial calipers except snout length, eye diameter, interorbit, upper jaw, distance between mandibular pores, caudal peduncle depth, and caudal peduncle length which were measured with an ocular micrometer on a Wild M5® stereoscope. Fin-ray counts of median fins were made from X-rays as these counts were

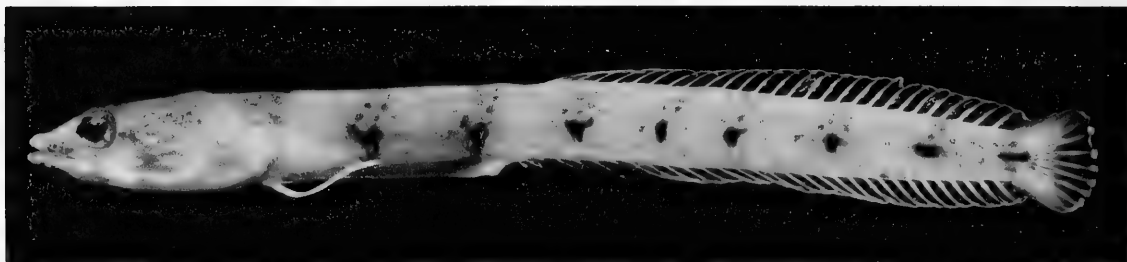


Fig. 1. Holotype of *Chaenopsis roseola*, USNM 221167. Anterior dorsal fin is depressed.

difficult to take directly from specimens. Head pore terminology follows Johnson and Greenfield (1976). Abbreviations of institutions cited are as follows: ANSP, Academy of Natural Sciences of Philadelphia; FMNH, Field Museum of Natural History, Chicago; FSBC, Florida Department of Natural Resources; GCRL, Gulf Coast Research Laboratory Museum; LACM, Los Angeles County Museum; UAIC, University of Alabama Ichthyological Collection; UF, Florida State Museum, University of Florida; UMML, University of Miami, Rosenstiel School of Marine and Atmospheric Sciences; USAIC, University of South Alabama Ichthyological Collection; USNM, United States National Museum of Natural History.

*Chaenopsis roseola*, new species

Flecked pikeblenny

Figs. 1–3

*Chaenopsis ocellatus* (in part). Springer and Woodburn 1960, p. 77. USNM 134923, two specimens.

**Holotype.**—USNM 221167 (originally USAIC 03661), 42.2 mm SL, male. 30°07'N, 86°45'W, northeastern Gulf of Mexico, about 35 km SSW of Ft. Walton Beach, Florida, 19 March 1977, 55 m. Collected with a semi-balloon trawl from a bottom of coarse shell rubble.

**Paratypes.**—USNM 221168 (3 specimens, 35.1–36.2 mm SL), collected with the holotype. GCRL 16893 (1, 42.7), 30°10'N, 86°50'W, about 35 km SSW of Ft. Walton Beach, FL, 22 May 1976, 53 m. GCRL 16894 (1, 28.4), 29°55'48"N, 86°06'36"W, about 40 km SW of Panama City Beach, FL, 6 Sept. 1977, 37 m. ANSP 143748 (1, 36.3) 30°09'30"N, 86°50'30"W, about 35 km SSW of Ft. Walton Beach, FL, 30 Aug. 1976, 55 m. ANSP 143749 (1, 31.5), 29°50'N, 86°06.5'W, about 30 km SW of Panama City Beach, FL, 20 July 1975, 41 m. UF 27444 (1, 41.0), 29°48'00"N, 86°03'30"W, about 40 km SW of Panama City Beach, FL, 4 June 1974, 40 m. UF 27445 (1, 29.9), 28°19'00"N, 84°21'00"W, about 60 km SSE of Apalachicola, FL (Florida Middle Grounds), 18 June 1974, 50 m. LACM 38701-1 (1, 34.8), 29°55'48"N, 86°06'36"W, about 40 km SW of Panama City Beach, FL, 6 Sept. 1977, 37

Table 1.—Frequency of counts for western Atlantic short-bodied *Chaenopsis*. All counts (except pectoral rays) for *C. roseola* include the holotype, seven paratypes, and two non-type specimens (USNM 134923). Pectoral fin ray counts include only the type material in which accurate counts could be made. \* = holotype.

	Dorsal fin										
	Spines		Rays						Total elements		
	17	18	26	27	28	29	30	44	45	46	47
<i>C. roseola</i>	6	4*	3*	3	4			5*	5		
<i>C. stephensi</i> (LACM 20157)	1				1				1		
<i>C. sp.</i> (UMML 28601)	1						1				1
	Anal fin rays			Pectoral fin rays				Vertebrae			
	29	30	31	12	13	14	48	49	50	51	52
<i>C. roseola</i>	4*	6		5*	8*	1	1	9*			
<i>C. stephensi</i> (LACM 20157)		1			2			1			
<i>C. sp.</i> (UMML 28601)			1		2						1

m. FMNH 83918 (1, 30.5), 29°55'48"N, 86°06'36"W, about 40 km SW of Panama City Beach, FL, 6 Sept. 1977, 37 m. UAIC 5948.01 (1, 28.6), 29°55'48"N, 86°06'36"W, about 40 km SW of Panama City Beach, FL, 6 Sept. 1977, 37 m. USAIC 06271 (1, 30.0), 29°55'48"N, 86°06'36"W, about 40 km SW of Panama City Beach, FL, 6 Sept. 1977, 37 m.

*Diagnosis.*—A short-bodied species of *Chaenopsis* with relatively few vertebrae (48–49), few dorsal fin elements (XVII–XVIII, 26–28; 44–45 total) and few anal fin elements (II, 29–30). Eight black blotches present along the side, first through sixth typically inverted triangles, seventh and eighth horizontally elongate blotches. Flecks of rusty or pink pigment scattered over entire body with two or three prominent (though variable in shape) flecks on cheek. Dorsal fin low in both sexes. Males with a black blotch on dorsal fin membranes between spines I and IV. Palatine teeth in one row, those in anterior section of row moderate in size (none noticeably enlarged), those in posterior section small.

*Description.*—Vertebral and fin-ray counts are given in Table 1. Sixteen precaudal and 32–33 caudal vertebrae. Dorsal fin low in both sexes (Fig. 2), composed of XVII–XVIII spines and 26–28 unbranched rays (44–45 total elements). Anal fin with two closely spaced spines and 29–30 unbranched rays. Pectoral fin rounded, composed of 12–14 unbranched rays. Pelvic fin I, 3; first and second rays elongate, third short and inconspicuous (about as long as pelvic spine). Body proportions are given in Table 2.

Snout bluntly V-shaped when viewed from above, i.e., lateral edges converge from the posterior nostril forward (Fig. 3). Forehead sloping when viewed from side (Figs. 1, 3). Lower jaw projecting slightly, visible from

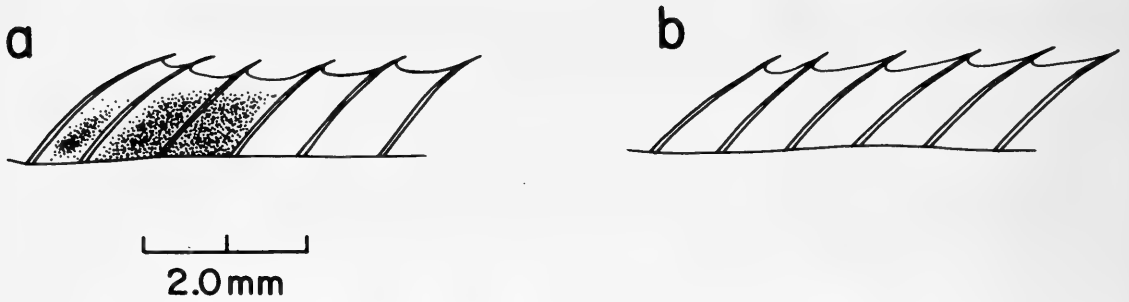


Fig. 2. Anterior dorsal fins of a) male (USNM 221167, holotype) and b) female (USNM 221168, paratype) of *Chaenopsis roseola*.

above. Dewlap on lower jaw extending to the anterior edge of orbit. Anterior nostril tubular, slightly shorter in length than maximum width of bony interorbit. Posterior nostril with a raised rim. Tongue long, slender, coming to a rounded point. Tip of tongue extends past vomerine tooth patch which is anterior to origin of palatine tooth row.

Outer tooth row of upper jaw bluntly U-shaped, composed of canines anteriorly and laterally. Teeth largest at corner of snout and decreasing in size posteriorly (ANSP 143748 with 5 canines across the left side of the front of the snout, followed by 19 teeth in the lateral series). Two to 4 irregular rows of fine pointed teeth behind the outer row on anterior part of mouth, extending in a wedge from mid-line outward and backward to the fourth tooth of the lateral series. Palatine teeth 17–18, in a single row originating near the thirteenth or fourteenth tooth of lateral series; anterior teeth in row moderate in size and pointed (7 in ANSP 143748) followed by a series of small teeth (10 in ANSP 143748). A few minute teeth on the vomer (3 in ANSP 143748). Outer tooth row of lower jaw bluntly U-shaped, composed of canines anteriorly (4 across the left of the front in ANSP 143748), with lateral series of teeth composed of canines anteriorly grading to low rounded teeth posteriorly (ANSP 143748 with 5 lateral canines, followed by 12 close-set moderate, pointed teeth, followed by 12 smaller close-set teeth, those in posterior part of latter section low and rounded). Teeth behind outer row similar to those in upper jaw. Two to 4 irregular rows of low pointed teeth in a wedge extending from middle of jaw back to fifth lateral canine.

Head pores are illustrated in Fig. 3: Nasal, 1 pair; anterofrontal, 1 pair; infraorbital, 5 pairs; supraorbital, 3 pairs; commissural, 1 median; supratemporal, 1 median + 1 pair; posttemporal, 4 pairs; preopercular, 5 pairs; mandibular, 4 pairs.

*Color description.*—Holotype, USNM 221167, 42.2 mm SL, male (Fig. 1); notes taken shortly after preservation in formalin and transfer to 45% isopropyl alcohol. Background color straw. Body with 8 black blotches along flank, extending ventrad from midline. First located over middle of

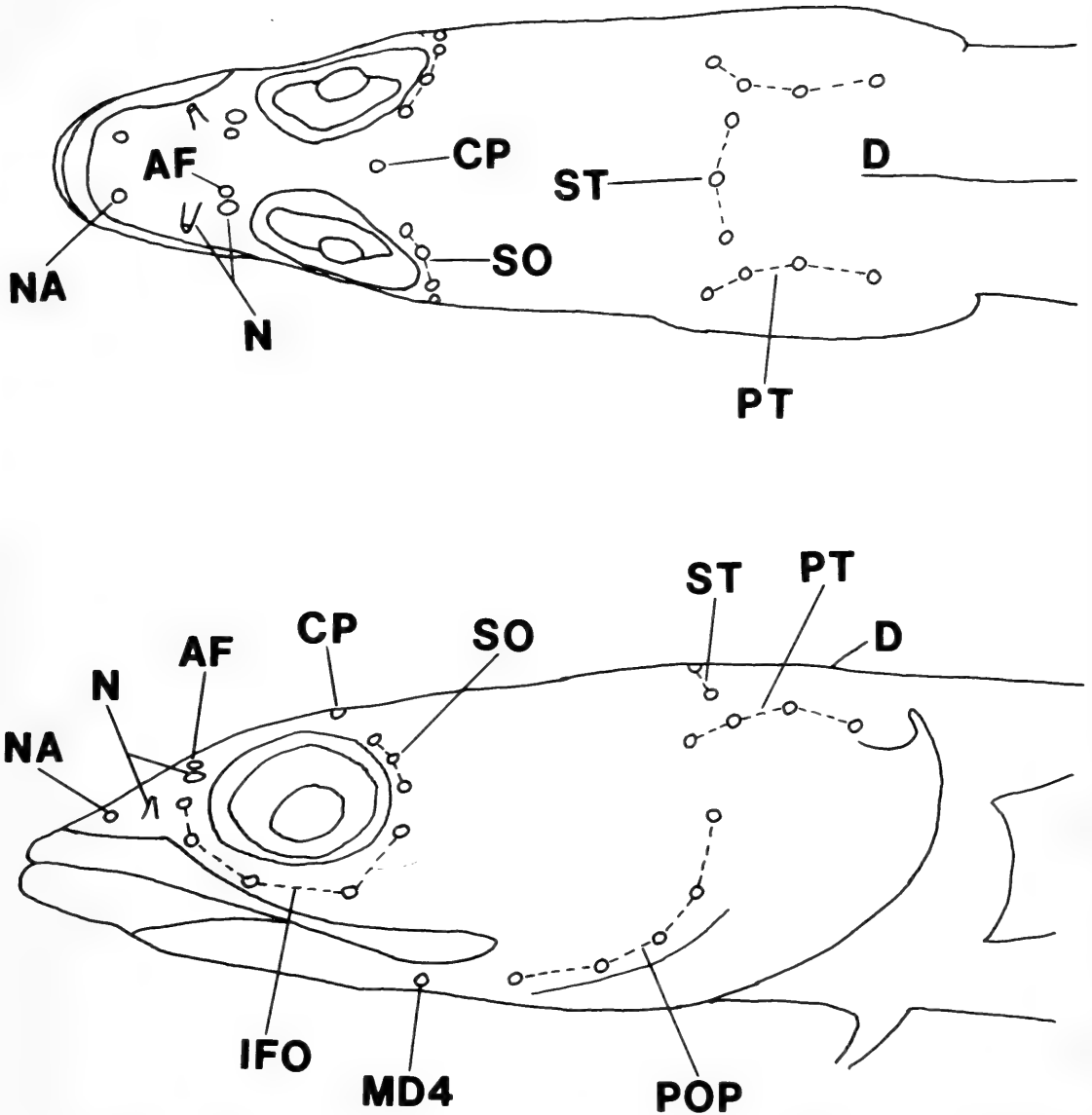


Fig. 3. Semi-diagrammatic drawing of the head-pore pattern of *Chaenopsis roseola* (UF 27444). Pores are enlarged to illustrate their positions. Pores within a series are connected by a dashed line. N = nostrils, NA = nasal, AF = anterofrontal, CP = commissural, SO = supraorbital, IFO = infraorbital, MD4 = fourth mandibular, POP = preopercular, PT = post-temporal, ST = supratemporal, D = dorsal fin origin.

belly, last on caudal peduncle. On left side, blotches 1–3 and 5–6 inverted triangles, 4 more rectangular, 7–8 horizontally elongate; blotches 1 and 2 each with 2 pink flecks within triangles. On right side, 1–6 inverted triangles, 7–8 horizontally elongate; blotches 1, 2, and 4 with pink flecks within triangles. Blotches 1–7 each with 2 rows of melanophore clusters (forming saddles) extending upward and across dorsum. A saddle also present anterior to the pectoral fin bases and concentrations of melanophores present

Table 2.—Morphometrics of western Atlantic short-bodied *Chaenopsis*. *Chaenopsis roseola*: 1 = GCRL 16893; 2 = USNM 221167; 3 = UF 27444; 4 = ANSP 143748; 5, 6, 7 = USNM 221168; 8 = LACM 38701-1; 9 = ANSP 143749; 10 = FMNH 83918; 11 = USAIC 06271; 12 = UF 27445; 13 = UAIC 5948.01; 14 = GCRL 16894. \* = holotype. Head length through upper jaw expressed as thousandths of the standard length. MP = mandibular pore index. M = male. F = female.

Species	Chaenopsis roseola														Chaenopsis stephensi	Chaenopsis sp.			
	Specimen	1	2*	3	4	5	6	7	8	9	10	11	12	13	14	Mean	(Range)	Holo-type LACM 20157	UMML 28601
SL (mm)	42.7	42.2	41.0	36.3	36.2	36.0	35.1	34.8	31.5	30.5	30.0	29.9	28.6	28.4			44.8	49.9	
Head length	253	258	249	253	240	225	245	241	238	243	243	258	245	243	245	(225-258)	259	212	
Predorsal length	213	211	207	218	204	192	214	197	206	200	207	217	206	211	207	(192-218)	230	186	
Preanal length	466	486	485	496	500	492	479	477	492	430	483	475	483	444	476	(430-500)	487	465	
Depth at D <sub>1</sub> origin	91	100	88	88	83	97	97	86	92	85	80	90	84	85	89	(80-100)	87	76	
Depth at A <sub>1</sub> origin	75	81	78	69	75	78	74	78	76	72	67	77	70	70	74	(69-81)	78	72	
Caudal ped. depth	50	47	47	47	46	46	48	49	55	49	54	50	54	47	49	(46-55)	40	40	
Caudal ped. length	42	48	40	39	39	46	37	45	46	48	46	45	42	44	43	(37-48)	36	24	
P <sub>1</sub> fin length	115	133	132	116	122	133	140	121	121	125	137	137	133	123	128	(115-140)	116	132	
P <sub>2</sub> fin ray 1	103	114	129	124	127	122	—	118	133	134	133	134	133	127	125	(103-134)	94	94	
P <sub>2</sub> fin ray 2	152	168	176	179	171	167	—	170	184	187	200	187	189	180	178	(152-200)	141	148	
Head depth	62	—	63	66	64	—	71	—	63	62	60	64	63	60	63	(60-71)	60	54	
Head width	73	92	83	80	80	92	—	—	79	74	73	94	73	85	81	(73-94)	91	74	
Snout length	53	51	51	60	51	45	58	56	55	53	51	54	55	57	54	(45-60)	56	47	
Pigmented eye	42	45	39	41	47	46	40	43	46	47	49	47	48	50	45	(39-50)	36	40	
Interorbit	11	11	12	10	8	8	10	10	10	9	8	11	8	9	10	(8-12)	11	8	
Upper jaw	133	120	124	127	93	93	103	115	107	102	103	112	108	104	110	(93-133)	141	84	
MP	9.3	8.0	9.2	10.4	9.4	8.4	9.6	9.5	—	9.2	9.0	7.9	10.8	10.6	9.3	(7.9-10.8)	>10.0	7.9	
Sex	M	M	M	M	F	F	F	M	F	?	?	M	?	?	?		F	F	

under the opercular flaps at the bases of this saddle. Faint rows of melanophores across dorsum between each of the 8 saddles. Clusters of melanophores scattered along flank. Small, irregularly shaped pink flecks scattered along dorsum. Eleven pairs of pink dots present on either side of body along anal fin base. Pink blotch present on upper one-third of right pectoral fin base, not present on left side. No pigment on belly. Melanophores scattered on head, most dense behind eye extending posteriorly to edge of preopercle. Melanophores present on interorbit, preorbit, suborbit, upper and lower lips, isthmus, lower branchiostegal membrane (few on upper membrane), chest, pectoral fin base, and operculum. Pink flecks present on operculum, preoperculum, snout, and upper lip (including fold above upper lip). Three pink dots present on anterior edge of lower lip. Iris pink. Cheek with 2 prominent pink horizontally elongate blotches; larger blotch posterior to eye (at level of pupil), smaller one below anterior edge of larger blotch, above maxillary. On right side of head this smaller blotch is narrower than on left side. Dorsal fin membrane between spines I–IV with a concentration of melanophores (Fig. 2) which form an ill-defined but prominent blotch (darkest between II and IV). Scattered melanophores present on most spines and rays of dorsal fin. Anal fin with a faint concentration of melanophores on membrane between spines and first ray. Scattered melanophores present on most rays. Scattered melanophores present on caudal fin, concentrated at center of base of fin. Pectoral fin unpigmented. Pelvic fin with few melanophores on bases of rays.

Paratype, USNM 221168, 36.0 mm SL, female. Color of freshly preserved specimen similar to holotype except generally less intensely pigmented. Lateral blotches similar on both sides; 1–6 inverted triangles, 7–8 horizontally elongate. Blotches 2, 3, 4, 6, and 7 with pink flecks within blotches. Pink blotch present on upper pectoral fin base of both sides. Eleven pairs of pink dots present along body at anal fin base. Left cheek with upper pink blotch broken into 2 smaller blotches. Lower blotch also broken into 2 separate blotches. Right cheek with blotch behind eye broken into 3 spots with no lower blotch present. Melanophores scattered over head although not as densely as in holotype. Lower jaw with melanophores broken into 4 bands with unpigmented areas between them. No black blotch on anterior dorsal fin.

Basic color pattern similar in all other specimens examined although intensity varies greatly. Rarely an individual has one of the black lateral blotches ill-defined or broken, giving the appearance of 2 proximal blotches. Live specimens show rust-colored instead of pink-colored flecks. These flecks turn pink upon fixation in formalin and fade entirely after a few months of preservation in isopropynol. Prominent, though variously shaped, rusty or pink flecks present on the cheek of all specimens.



Peritoneum of those specimens examined internally with scattered melanophores, flecks of pink and two black blotches (one on either side) in the shape of inverted triangles directly beneath and corresponding to the first lateral exterior blotches. One male (ANSP 143748) with melanophores covering belly and concentrated in a semi-circle in front of the genital area; no pigment on belly of other specimens. Black pigment at the corner of the mouth inside the lips of ANSP 143748.

*Comparisons.*—Of the western Atlantic species, *C. roseola* is most similar to *C. stephensi* with which it shares a short body and low meristic counts relative to other Atlantic species of *Chaenopsis* (Robins and Randall, 1965). *Chaenopsis roseola* differs from *C. stephensi* in a number of characters including pigment pattern, palatine tooth pattern, and some morphometric characters.

The color pattern of *C. roseola* (in preservative) differs from that of *C. stephensi* in that 8 instead of 6 lateral blotches are present. Robins and Randall (1965) indicate that 5 blotches are present along the side of the holotype of *C. stephensi*, but we count 6 faint blotches along the side. Unfortunately, the life colors of *C. stephensi* are unknown.

The palatine tooth row of *C. roseola* is composed of teeth of essentially two sizes, the anterior portion of the row being of moderately sized teeth with the posterior portion of small teeth. The palatine tooth row of *C. stephensi* is composed of 16 or 17 (some are broken) teeth which are irregular in size with large teeth interspersed throughout the row of otherwise small teeth.

Several morphometric differences exist between *C. roseola* and *C. stephensi* although these may not always be diagnostic when used alone, a situation common in chaenopsids (Stephens, 1963) including the genus *Chaenopsis* (Robins and Randall, 1965). Excluding characters which apparently vary allometrically (see below), *C. roseola* differs from *C. stephensi* in having a shorter predorsal length, a larger eye, and a deeper caudal peduncle (Table 2). Since only a single specimen of *C. stephensi* is known (a second is doubtful), establishment of morphometric variation in that species is presently impossible; reliable comparison of such characters must await the collection of more material of *C. stephensi*.

*Chaenopsis roseola* differs from the Arrowsmith Bank specimen (UMML 28601) identified as *C. stephensi* by Robins (1971) in number of vertebrae, number of dorsal fin rays, number of anal fin rays (Table 1), and number of blotches along the side (7 in UMML 28601) as well as several non-allometric morphometric characters including head length, head depth, predorsal length, caudal peduncle depth, and caudal peduncle length (Table 2).

*Chaenopsis roseola* differs from the other known western Atlantic *Chaenopsis* species principally in having a shorter body and fewer vertebrae, fin-

ray elements, and lateral body markings. *Chaenopsis roseola* as well as *C. stephensi* belong to the short-bodied species group as defined by Böhlke (1957b) and thus are allied with *C. coheni* and *C. deltarrhis* of the eastern Pacific.

*Range and habitat.*—The type-material of *Chaenopsis roseola* is from the northeastern Gulf of Mexico, from the head of the De Soto Canyon eastward and southward to the Florida Middle Grounds. Additional Gulf of Mexico specimens have been collected as far south as off the Tampa Bay area (see below). Two specimens referable to *C. roseola* have been collected from the Atlantic Ocean off North Carolina by D. J. Stewart.

Recently, the area adjacent to and just east of the northern rim of the De Soto Canyon has been trawled and dredged extensively; the samples taken were marked by abundant shell and rubble. This area, from which the majority of the specimens of *C. roseola* were captured, was examined during a 3-hour dive by the research submersible DIAPHUS during June 1978. Observations made during this dive by one of us (RLS), recorded on audiotape for later transcription, revealed a bottom with "windrows" of rubble and coarse shell hash. These were of about 1–3 m width, with intervening areas of silica sand, of about the same width. Numerous observations of small fishes, thought to be the pirate blenny, *Emblemaria piratula*, and *Chaenopsis roseola* (recorded as *Chaenopsis* sp.) were made. The fish were observed to dart to and from rubble and shell fragments, and to retreat backward into the cover when approached closely by the submersible. On several occasions the submersible was placed at rest on the bottom for more prolonged observation. Although slight protrusion of the head region of a chaenopsid was occasionally detected, this was never close enough to obtain a diagnostic photographic or videotape record. In addition, the pearly razorfish, *Hemipteronotus novacula*, was frequently noted projecting from burrows. The sand perch, *Diplectrum formosum*, was also frequently noted in this area.

Extensive dredge and trawl operations along the northeastern Gulf shelf show that these shell rubble areas form mosaics north and east of De Soto Canyon. Several previously unknown or poorly known species have been collected from this habitat with *C. roseola*. These include *Emblemaria piratula* (Chaenopsidae), *Gobulus myersi*, *Palatogobius paradoxus* (Gobiidae), an undescribed species of *Gillelus* (Dactyloscopidae), and two undescribed ophichthid eels (Ophichthidae).

Collection depths of *C. roseola* range from 33 to 64 m, but suitable habitat is present beyond this depth range. *Chaenopsis roseola* probably inhabits the entire lower shelf region of the northeastern Gulf where the preferred shell rubble patches exist, as well as the eastern continental shelf of the southeastern United States.

*Etymology.*—The name *roseola* is from the Latin *roseus*, rosy colored. This name is selected for the pink or rust colored flecks (in living adults) reminiscent of roseola or measles.

*Discussion.*—Stephens (1963) attributed the wide variation seen in morphometric characters in chaenopsids to four factors: 1) growth, 2) individual variation, 3) sexual dimorphism, 4) error in measurement. A fifth factor, shrinkage of specimens in preservative, may also account for some variation in measurements. The holotype of *C. stephensi* has apparently undergone some shrinkage since its description, as our measure of its standard length, 44.8 mm, is less than that given by Robins and Randall (1965), 45.8 mm. This further emphasizes the need of more material of *C. stephensi* before an adequate comparison with *C. roseola* can be made.

At least two morphometric characters vary allometrically in *C. roseola* (Table 2). Larger individuals have proportionately shorter pelvic fin rays and, at least among males, larger individuals tend to have proportionately longer upper jaws. Böhlke (1957b) discusses the allometry of the upper jaw in *Chaenopsis* and points out that the two species groups differ in the rate of change of the length of the upper jaw relative to the head length. In the short-bodied *coheni* group, the maxillary is longer at all stages of growth than in the long-bodied *ocellata* group. However, Stephens (1963) points out that the relative jaw elongation in the *coheni* group may be due to the increase in body elongation of the *ocellata* group. While in the male specimens of *C. roseola* the relative length of the upper jaw increases with growth, the opposite appears to be true for the four female specimens (although a good size range of females is lacking). Additional specimens are needed to determine the growth characteristics of the upper jaw in *C. roseola*.

Sexual dimorphism is subtle in *C. roseola*. Both sexes have low dorsal fins (Fig. 2) but males are distinguishable by a black blotch (which females lack) on the anterior dorsal fin. In *C. ocellata* the anterior dorsal fin mark (also present only in males) is used for display when defending territories (Robins *et al.*, 1959) and may serve a similar function in *C. roseola*. Robins and Randall (1965) describe the holotype of *C. stephensi* (presumably a female) as having a dusky area on the anterior part of the spinous dorsal fin. Females of *C. roseola* have no such pigment on the dorsal fin.

In the holotype of *C. stephensi* the second mandibular pore is closer to the first than to the third. In ten of the specimens of *C. roseola* the second pore is closer to the third than the first (MP index less than 10, Table 2). However, in three specimens the second is closer to the first (MP index greater than 10). This variation calls into question the use of this character for the delineation of related groups within the genus *Chaenopsis* (Böhlke, 1957b).

*Chaenopsis stephensi* was described from a single specimen apparently taken from Cubagua Island, Venezuela, at Allan Hancock station A28-39 at

a depth of 2 fathoms (Robins and Randall, 1965). However, in their remarks on the species, these authors implied some doubt as to the locality data: "Even if a locality error is involved, *stephensi* is unidentifiable with any Pacific species." This comment also reflected their assessment that although close to the Pacific *C. coheni*, their species was in fact distinct. Subsequently, Robins (1971) stated, in reference to this matter, that "Since *C. stephensi* belonged to a species group otherwise known from the Pacific shore of Central America and since the Allan Hancock collections encompassed both coasts, there was reason to doubt the origin of the holotype," but reported on a second specimen (UMML 28601) from Arrowsmith Bank off Yucatan, Mexico which verified the provenance of *C. stephensi*.

The taxonomic status of the Arrowsmith Bank specimen reported by Robins (1971) is unresolved. In some characters (predorsal length, eye size) it resembles *C. roseola*. In other characters (caudal peduncle depth) it more closely resembles *C. stephensi*. However, in many characters it is unique (e.g., number of vertebrae, dorsal rays, and anal rays, head length, head depth, upper jaw length, caudal peduncle depth). More material of this form is needed to resolve its status. Additional material from Venezuela is also needed to elucidate relationships within this distinctive sub-group of *Chaenopsis* in the western Atlantic.

*Additional material examined.*—*Chaenopsis roseola*: USNM 134923 (2, 29–33). 28°45'00"N, 85°02'00"W, off Cedar Keys, FL, 15 March 1885, about 64 m. FSBC 6567 (1, 22.2), 27°37'N, 83°58'W, off Tampa Bay, FL, 20 Nov. 1966, 55 m. FSBC 6889 (1, 34.6), 27°37'N, 83°58'W, off Tampa Bay, FL, 2 Aug. 1967, 55 m. Uncatalogued (1, 31.3), R/V EASTWARD cruise E5-77, sta. 11, 34°34.2'N, 75°13.4'W, off North Carolina, 3 Aug. 1977, 33 m. Uncatalogued (1, 26.5), R/V EASTWARD cruise E5-77, sta. 19, off North Carolina. *Chaenopsis stephensi*: LACM 20157, holotype, Cubagua Island, Venezuela, 10°49'25"N, 64°16'00"W, 15 April 1939. 2 fathoms (3.7 m). *Chaenopsis* sp. (*stephensi* of Robins, 1971): UMML 28601, Arrowsmith Bank, off Yucatan, Mexico, 21°05'N, 86°31'W, 20 Aug. 1970, 275 m.

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THE RELATIONSHIPS OF THE SOUTH AMERICAN  
PYGMY CHARACOID FISHES OF THE GENUS  
*ELACHOCHARAX*, WITH A REDESCRIPTION  
OF *ELACHOCHARAX JUNKI*  
(TELEOSTEI: CHARACIDAE)

Stanley H. Weitzman and J. Géry

*Abstract.*—*Elachocharax junki* (Géry), previously known only from the holotype, is redescribed on the basis of four additional specimens from the Rio Madeira basin and one from a tributary of the Rio Negro, Amazonas, Brazil. This species, originally described as *Geisleria junki* and placed in a monotypic subfamily, Geisleriinae, is here considered to be a species of *Elachocharax* of the characid subfamily Characidiinae. *Elachocharax* consists of three species, *E. pulcher*, *E. geryi*, and *E. junki*. Their relationships are discussed and a key is provided for their identification. The relationships of *Elachocharax* to the other genera of the Characidiinae is treated. The Geisleriinae and Elachocharacinae of Géry (1971) are rejected and placed as synonyms of the Characidiinae.

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The first known pygmy characoid related to *Characidium* Reinhardt and *Jobertina* Boulenger but having a very long dorsal-fin base with 17 to 20 rather than 10 to 14 dorsal-fin rays was *Elachocharax pulcher* Myers (1927) from the central region of the Rio Orinoco in Venezuela. In recent years, further collecting in the Amazon basin has resulted in the description of additional nominal species of *Elachocharax*. *Elachocharax georgiae* Géry (1965) was shown by Weitzman and Kanazawa (1978) to be a synonym of *E. pulcher* but two additional valid species have been described. Géry (1971) established a new genus and species, *Geisleria junki* (here placed in *Elachocharax*), from the Rio Novo in an area about 45 km east of Porto Velho in the basin of the Rio Madeira, Brazil. Weitzman and Kanazawa (1978) described a new species, *Elachocharax geryi*, from the middle of the Amazon basin near Manaus, Brazil, and from Caño Muco, an upper tributary of the Rio Orinoco in Colombia. They further reported the extension of the known range of *Elachocharax pulcher* from the mid Rio Orinoco basin to an area covering much of the central Amazon basin.

Géry (1971) assigned *Geisleria junki* to a new subfamily, Geisleriinae, based on its apparent possession of two rows of premaxillary teeth, presumed absence of ectopterygoid teeth, the presence of what appeared to be maxillary teeth, a supposed absence of "suborbital" bones, and absence of

a cranial fontanel. At that time Géry recognized two new, but related groups at the subfamily level, the Geisleriinae and the Elachocharacinae, the latter based on *Elachocharax* of Myers (1927). He included these taxa along with the Characidiinae in a family, the Characidiidae. This family, here tentatively recognized as a subfamily of the Characidae, includes *Characidium*, *Jobertina*, *Klausewitzia* Géry (1965), *Elachocharax*, and *Ammocryptocharax* Weitzman and Kanazawa (1976). Géry (1971) correctly pointed out that the phylogenetic relationships of this family group to other characoids are uncertain, a fact agreed to by Weitzman and Kanazawa (1978) who briefly reviewed the history of the placement of these fishes by ichthyologists. Géry further noted that the species of the Elachocharacinae and the Geisleriinae form a group of small fishes related to *Characidium* but with a long-based dorsal fin and apparently living in very slow-moving waters. Species of *Characidium*, *Jobertina*, and *Ammocryptocharax* are ordinarily found in streams of moderate to rapid flow whereas *Elachocharax*, *Klausewitzia*, and the nominal *Geisleria* occur in quiet waters of large river basins. Weitzman and Kanazawa (1976) tentatively rejected the Elachocharacinae and Geisleriinae as valid taxa at the subfamily level and adopted a hypothesis that all the genera noted above belong to a subfamily, the Characidiinae, whose characoid relationships are uncertain.

The examination of a specimen from the Rio Negro basin, here considered a female of the nominal *Geisleria junki*, of four specimens of this species from the Rio Madeira basin, and a reexamination of the holotype of *G. junki* has allowed a new interpretation to be placed on the phylogenetic relationships among the species *Elachocharax pulcher*, *Elachocharax junki*, and *Elachocharax geryi*.

A key is presented below to the species of *Elachocharax*. *Elachocharax junki* is redescribed and the relationships among the three species are discussed. Finally, the possible relationships of *Elachocharax* with other species and genera of the Characidiinae is reviewed.

### *Elachocharax* Myers

*Elachocharax* Myers, 1927:114, original description, type by monotypy *Elachocharax pulcher* Myers (1927).—Géry, 1977:122, brief discussion.—Weitzman and Kanazawa, 1978:160, redefinition and discussion of relationships.

*Elacocharax* Weitzman and Kanazawa, 1976:328, misspelling for *Elachocharax*.

*Geisleria* Géry, 1971:154, original description, type by monotypy *Geisleria junki* Géry (1971).—Géry, 1977:122, brief discussion.

Weitzman and Kanazawa (1978) redefined the genus and discussed its presumed phylogenetic relationships. Inclusion herein of the species *E. jun-*



*ki* modifies that description. A discussion of the relationships of the genus will be found below, after the redescription of *E. junki*.

*Diagnosis*.—The following two correlated characters will distinguish *Elachocharax* from all other known genera in the Characidiinae. Total number of dorsal-fin rays 17–22. Anterior origin of the anal fin either ventral to or in advance of the posterior termination of the dorsal-fin base.

*Description*.—Other characters useful in defining *Elachocharax* are as follows. Premaxillary teeth in single series, partly tricuspid, bicuspid, and unicuspid, or only unicuspid. Maxillary and mesopterygoid teeth absent. Dentary teeth in two rows. Outer row of partly tricuspid, bicuspid, and unicuspid, or only unicuspid teeth. Inner row unicuspid. Ectopterygoid teeth present, unicuspid, and nearly uniserial. Mouth terminal or snout slightly in advance of lower jaw. Adipose fin present or absent. Scale rows between anterior dorsal-fin origin and pelvic-fin origin 8. Predorsal scales 8–10. Perforated lateral-line scales few, 5–9. Scales in a lateral series 26–33. Scale rows around caudal peduncle, 14 (Weitzman and Kanazawa, 1978, erroneously reported 12 scale rows around caudal peduncle for *E. pulcher*). Vertebrae 29–32, including those of Weberian apparatus and terminal centrum. Branchiostegal rays 4–5. Body relatively short, greatest depth at dorsal-fin origin 23–30% of standard length. First and second infraorbital bones with a well developed laterosensory canal. Third, fourth, and fifth infraorbital bones apparently absent.

Key to the Species of *Elachocharax*

- 1. Premaxillary teeth tricuspid anteriorly followed by a few bicuspid and/or unicuspid teeth. Dentary with tricuspid teeth anteriorly followed by none, one, or a very few bicuspid teeth and then several unicuspid teeth lateroposteriorly. Adipose fin present. Branchiostegal rays 5 ..... *Elachocharax pulcher*
- 2. Premaxillary and dentary teeth unicuspid. Adipose fin absent. Branchiostegal rays 4 ..... 3
- 3. Caudal fin without obvious vertical dark bars. Teeth of ectopterygoid 8–13. Inner row dentary teeth 19–20. Upper limb gill rakers 5–6. Anterior anal-fin origin in advance of posterior termination of dorsal-fin base. Snout length about 5.4–6.1% of standard length. Caudal peduncle length about 19.0–22.0% of standard length ..... *Elachocharax junki*
- 4. Caudal fin with 13–14 narrow vertical dark bars. Teeth of ectopterygoid 4–5. Inner row dentary teeth 13–16. Upper limb gill rakers 3. Anal-fin origin ventral to or slightly posterior to posterior termination of dorsal-fin base. Snout length about 6.0–8.0% of standard length. Caudal peduncle length about 16.0–19.0% of standard length ..... *Elachocharax geryi*



A description and synonymies of *E. pulcher* and a description of *E. geryi* appear in Weitzman and Kanazawa (1978). Some additional localities for *Elachocharax pulcher* are as follows: FMNH 87812, (2), 13.8–14.6 mm SL, Peru, Rio Nanay, Mishana, about 33 km west of Iquitos (73°30'W, 3°50'S), 5 November 1974, Spieler and Poncho; MPM 24,697, (6), 12.1–14.7 mm SL, same locality as FMNH 87812; AMNH 38239, (2) 21.9–22.1 mm SL, Bolivia, Dept. Beni, Arroyo Grande, 4 km west of Guayaramerin, new road to Riberalta (65°27'W, 10°50'S), 23 October 1964, R. M. Bailey and W. Villaroel.

*Elachocharax junki* (Géry)

Figs. 1–6, Table 1

*Geisleria junki* Géry, 1971:154, original description, Brazil, Rondonia, Rio Novo, tributary to Rio Jamari about 45 km east of Porto Velho, Rio Madeira basin.—Géry, 1977:122, listed, brief discussion.—Weitzman and Kanazawa, 1978:161, discussion of relationships.

*Material examined*.—Holotype, collection of J. Géry, 22.4 mm SL, Brazil, locality as listed above in synonymy, collected 18 October 1967 by R. Geisler and W. Junk; MZUSP 14008, (1) 22.3 mm SL, Brazil, Amazonas, Igarapé Cobrinha, left bank of Rio Cuieiras, approx. 20 km from its mouth (60°30'W, 2°50'S), 28 January 1977, H. Britski and N. Menezes; collection of J. Géry, (4) 21.5–23.1 mm SL, Brazil, Amazonas, 44 km east of Humaitá along rodovia Trans-Amazonica, Rio Madeira basin (62°35'W, 7°35'S), 22 August 1976, H. R. Axelrod. Figure 1 is a map of localities.

*Description*.—Body relatively short in comparison to most members of Characidiinae; greatest depth at dorsal-fin origin. Profile of head and back from snout tip to dorsal-fin origin gently convex with a slight concavity at nape and dorsal to area of eyes. (Note holotype, Fig. 2, preserved with branchial apparatus and gill covers expanded and head extended dorsally, giving a greater concavity at nape than is present in specimens with branchial apparatus, gill cover, and head not in extended position, Figs. 3, 4.) Dorsal-fin origin in advance of pelvic-fin origin. Anal-fin origin in advance of posterior termination of dorsal-fin base. Profile of ventral surface of head convex. Belly slightly convex from region of isthmus to pelvic-fin origin. Profile of body between pelvic-fin origin and anal-fin origin gently convex to nearly straight. Caudal peduncle relatively short and deep. Both dorsal and ventral profiles of caudal peduncle slightly concave.

Head moderately long. Mouth nearly terminal or snout slightly in advance of lower jaw tip. Snout relatively blunt. Eye large, horizontal diameter exceeding snout length.

Teeth on dentary in 2 rows (Figs. 5, 6). Outer (anterior and lateral) row with 14 (13–17,  $\bar{x}$  = 15.5) 16 conic teeth. Inner row with 19 (19–20,  $\bar{x}$  = 19.5) 20 conic teeth. Premaxillary (Fig. 5) with a single row of 11 (12–15,



Fig. 1. Localities reported for *Elachocharax junki*. 1. Type locality Rio Novo, tributary to Rio Jamari, Rio Madeira basin, Brazil. 2. 44 km east of Humaitá along rodovia Trans-Amazonica, Rio Madeira basin. 3. Igarapé Cobrinha, Rio Cuieiras, Rio Negro basin.

$\bar{x} = 13$ ) 14 conic teeth. Maxillary toothless. Ectopterygoid with 8 (10–13,  $\bar{x} = 11.3$ ) 12 conic teeth in nearly a single row.

Branchiostegal rays 4, two slender anterior rays attached to anterior part of ceratohyal followed by a broad ray attached to posterior part of ceratohyal and another broad ray attached to epihyal. Gill rakers 6 (5–6,  $\bar{x} = 5.8$ ) 5 on upper limb and 6 (6–7,  $\bar{x} = 6.8$ ) 6 on lower limb. Frontal-parietal foramen greatly reduced, bounded by posterior borders of parietals and supraoccipital. A narrow antorbital bone present dorsal and posterolateral to posterior dorsal portion of first infraorbital. First (anterior) infraorbital of moderate size and well ossified in stained face bones of right side of specimen from Rio Cuieiras. First infraorbital with an anterior process extending dorsal and anterior to anterior dorsal slender process of maxillary bone. Second infraorbital bone primarily a narrow laterosensory tube but some additional bone present. Both first and second circumorbitals contain laterosensory canals. Other infraorbital bones apparently absent.

Scales cycloid, usually 4–5 radii on exposed field. Lateral line with 7 (7–

Table 1.—Morphometrics of *Elachocharax junki*. Standard length is expressed in mm. Other measurements are percentages of standard length. The coefficient of variation (CV%) is an expression of variation of the original measurements.

Locality	Brazil, Rio Novo (Holotype)	Brazil, 44 km east of Humaitá			Brazil, Rio Cueiras	Range	$\bar{x}$	SD	CV%
Standard length	22.4	21.2	21.5	22.4	23.1	22.3	21.2–23.1	0.689	3.112
Depth at dorsal-fin origin	29.9	28.3	26.0	27.7	29.4	30.0	26.0–30.0	1.545	7.583
Snout to dorsal-fin origin	47.8	47.6	46.5	49.1	45.9	48.4	45.9–49.1	1.184	3.782
Snout to pectoral-fin origin	29.0	28.8	28.8	28.1	28.1	27.4	27.4–29.0	0.609	2.920
Snout to pelvic-fin origin	55.8	51.9	51.2	50.9	50.2	53.4	50.2–55.8	2.058	4.971
Snout to anal-fin origin	77.2	73.1	74.0	72.8	71.9	74.9	71.9–77.2	1.882	3.868
Caudal-peduncle depth	16.1	14.6	14.0	14.3	15.2	15.2	14.0–16.1	0.759	7.171
Caudal-peduncle length	21.9	20.3	20.0	19.2	19.5	20.6	19.2–21.9	0.957	5.356
Pectoral-fin length	31.1	30.2	28.4	27.2	27.3	32.3	27.2–32.3	2.140	7.225
Pelvic-fin length	21.0	19.3	20.0	18.3	19.9	18.8	18.3–21.0	0.961	5.958
Length dorsal-fin base	33.0	33.5	33.5	31.7	34.6	33.2	31.7–34.6	0.940	4.697
Length longest dorsal-fin ray	17.9	16.5	16.3	15.6	17.7	17.9	15.6–17.9	0.981	9.070
Length anal-fin base	9.4	9.4	10.2	8.9	10.8	9.9	8.9–10.8	0.677	8.593
Length longest anal-fin ray	18.8	20.8	21.9	20.5	22.9	18.8	18.8–22.9	1.644	9.046
Bony head length	26.3	30.2	30.2	29.0	28.6	25.6	25.6–30.2	1.954	6.705
Head length to soft opercular border	28.6	31.6	31.6	30.8	30.3	29.6	28.6–31.6	1.777	3.208
Horizontal eye diameter	8.9	8.5	8.4	8.0	7.8	9.0	7.8–9.0	0.476	5.533
Snout length	5.4	6.1	6.0	5.8	6.1	5.4	5.4–6.1	0.329	8.154
Fleshy interorbital width	7.6	7.5	7.0	7.6	7.4	7.6	7.0–7.6	0.235	7.902
Upper jaw length	7.1	8.0	7.4	7.6	7.8	7.2	7.1–8.0	0.349	4.899
Eye to dorsal-fin origin	36.2	33.5	33.5	34.8	32.9	34.1	32.9–36.2	1.186	4.921
Dorsal-fin origin to caudal fin base	55.8	58.5	55.3	55.8	58.4	58.3	55.3–58.5	1.528	4.355

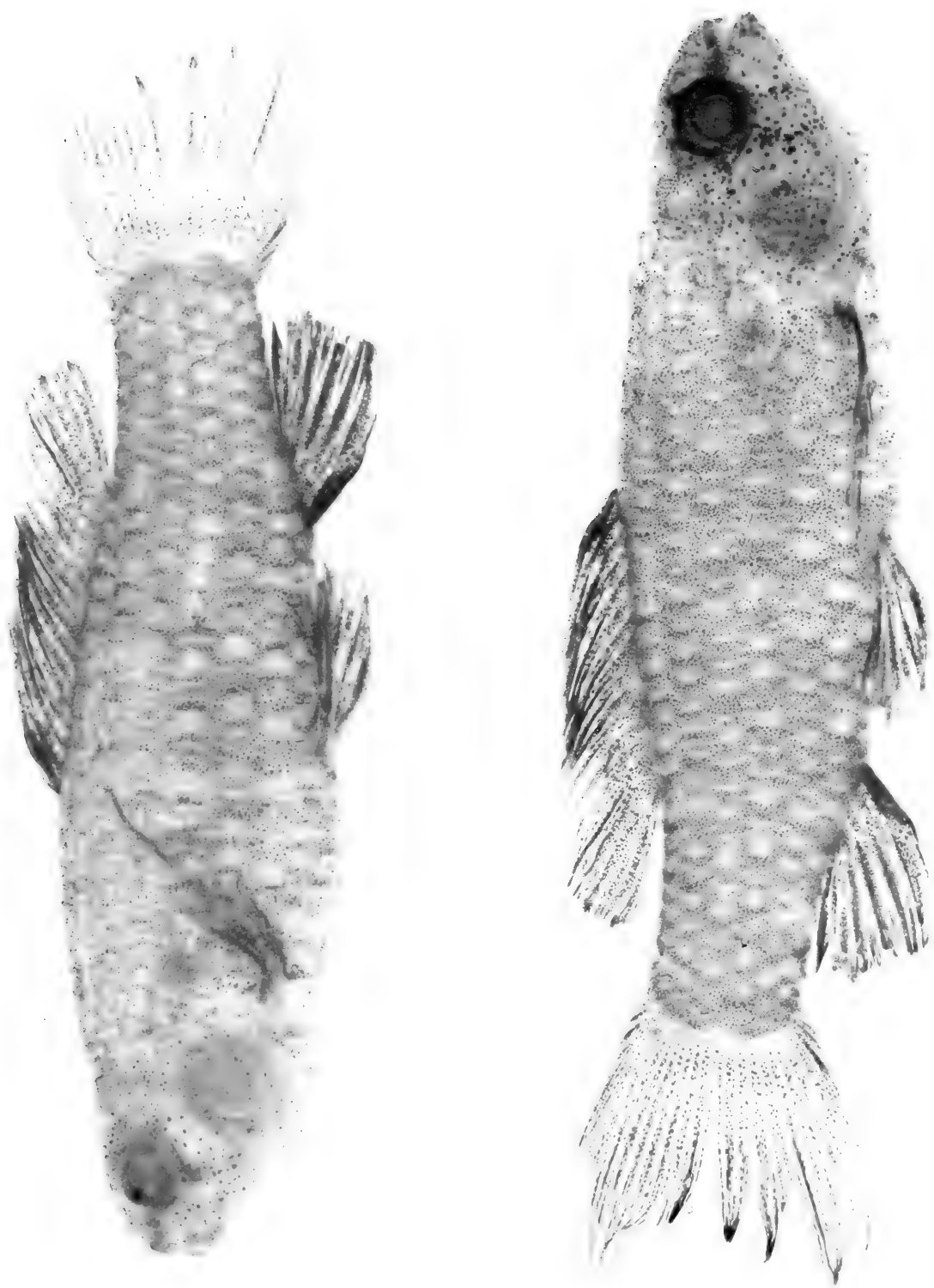


Fig. 2. Above, *Elachocharax junki* (Géry), holotype, SL 22.4 mm, left side, Rio Novo, tributary of Rio Jamari, Rio Madeira basin, Rondonia, Brazil. Below, right side of same specimen.

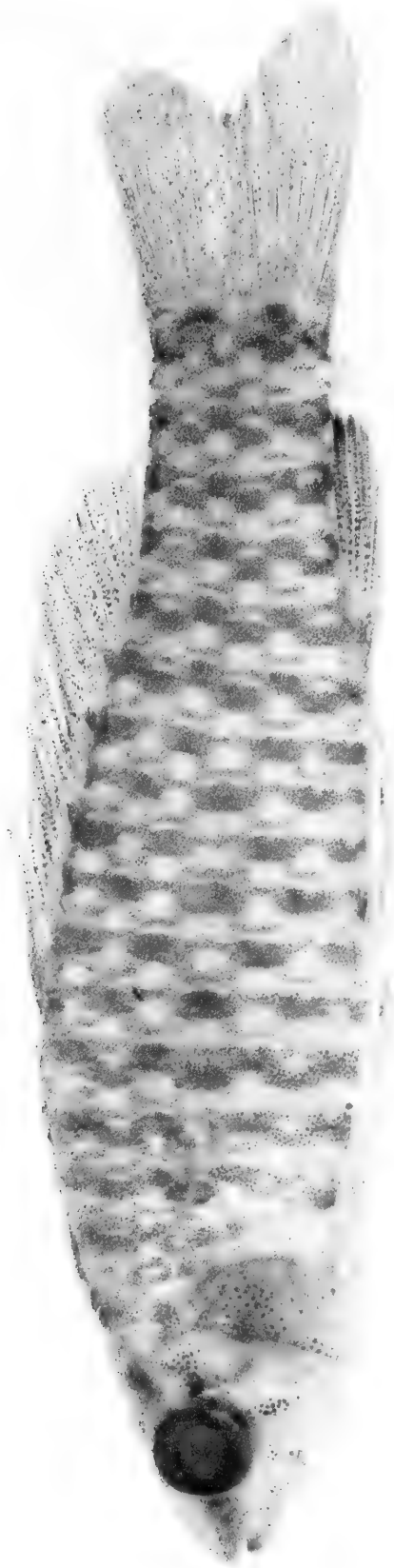


Fig. 3. *Elachocharax junki* (Géry), SL 23.1 mm, 44 km east of Humaitá, Rio Madeira basin, Amazonas, Brazil.

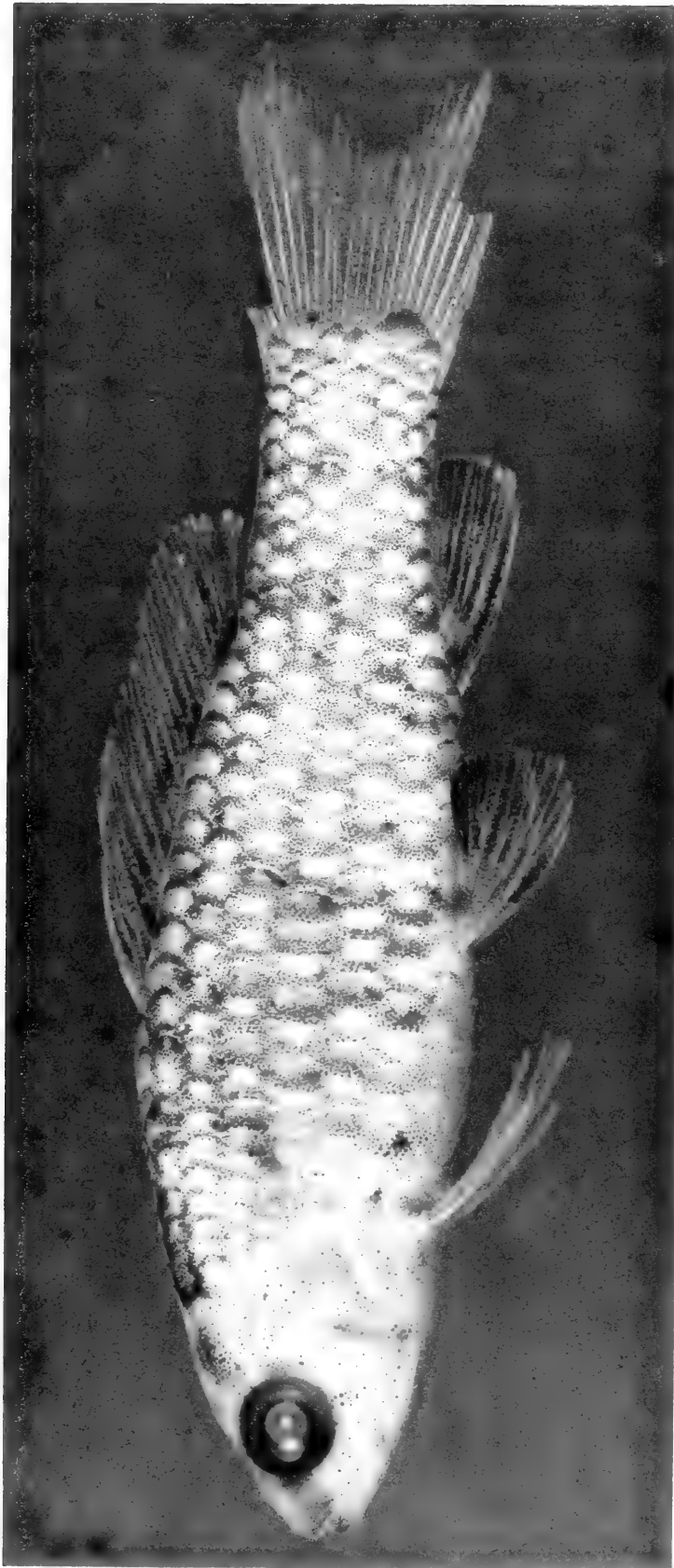


Fig. 4. *Elachocharax junki* (Géry) MZUSP 14008, SL 22.3 mm, igarapé Cobrinha, Rio Cuieiras, Rio Negro basin, Amazonas, Brazil.

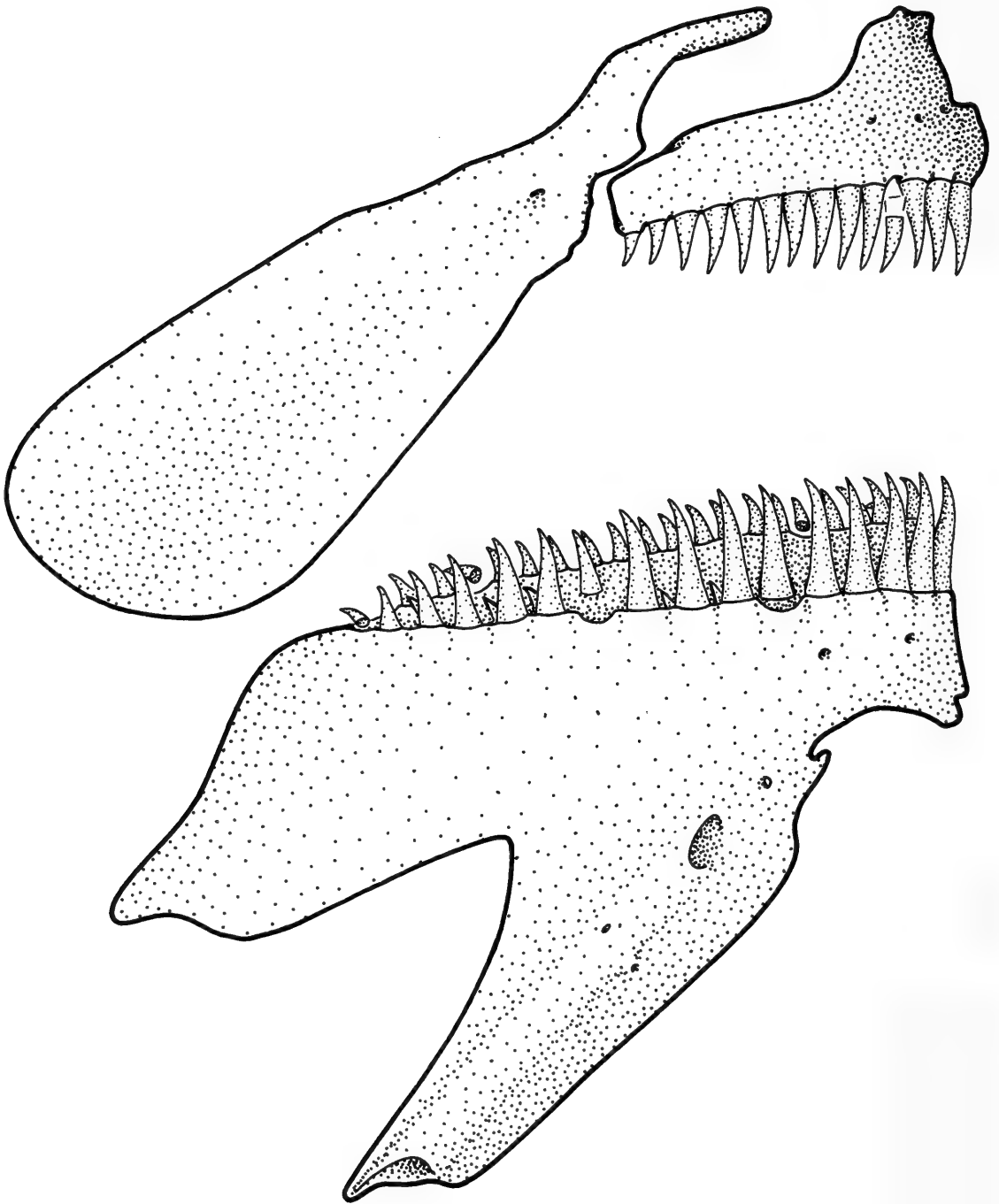


Fig. 5. *Elachocharax junki* (Géry), MZUSP 14008, SL 22.3 mm, igarapé Cobrinha, Rio Cuieiras, Amazonas, Brazil. Lateral view of premaxillary and maxillary and dentary bones of right side. Anterior is to the right. Outer dentary tooth row lies in a deep groove. Their replacement teeth develop in that groove. The inner row dentary teeth are seen posterior to the ridge behind the groove.

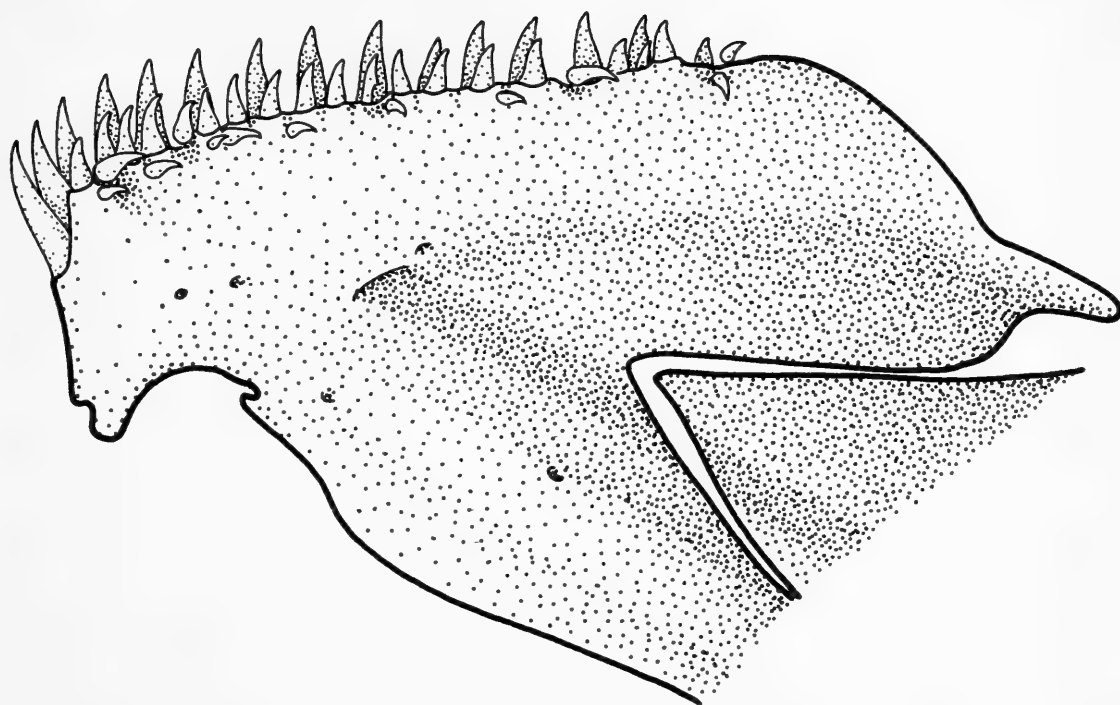


Fig. 6. *Elachocharax junki* (Géry), MZUSP 14008, SL 22.3 mm, igarapé Cobrinha, Rio Cuieiras, Amazonas, Brazil. Medial view of right dentary bone. Twenty inner row teeth are visible on the dentary ridge. Nine replacement teeth can be seen posterior to the inner row teeth. These replacement teeth point inwards toward the oral cavity. Anterior is to the left.

8,  $\bar{x} = 7.8$ ) 8 scales. Scales in a lateral series 31 (30–33,  $\bar{x} = 31.5$ ) 31. Scale rows between dorsal and pelvic fins 8 in all specimens. Scale rows around caudal peduncle 14 in all specimens. Predorsal scales 10 (9–10,  $\bar{x} = 9.3$ ) 9. Area on belly anterior to pectoral fin with scales.

Dorsal-fin rays iii,16 (iii,17 in two, iii,18 in one, and ii,19 in one) iii,18, last ray not split to its base. Adipose fin absent. Anal-fin rays ii,6 in all specimens, last ray split to its base. Pectoral fin elongate reaching to or somewhat beyond pelvic-fin origin. Pectoral-fin rays total 8 in all specimens, most rays undivided, sometimes middle two or three divided. Pelvic fin i,7 in all specimens. Pelvic fin relatively short, reaching anus, or near to it. Caudal fin forked with principal ray count 10/9 in all specimens.

Total number of vertebrae including Weberian apparatus and terminal centrum 32 in all specimens except one from near Humaitá which has 33.

*Color in alcohol.*—Background color pale yellowish brown, with dark brown chromatophores relatively dense except in central areas of pale scales. Definite dark vertical bars not readily apparent in some specimens (Figs. 2, 4) although in areas where scales have dark centers as well as dark borders, bars may appear in life as well as in preserved specimens (Fig. 3). If this is so, about 16 to 18 dark vertical bars appear present. Géry (1971:159)



remarked that other than scales being bordered in dark pigment, no really dark markings were present on body of holotype. Body pigment in preserved specimens of all three species of *Elachocharax* seems quite variable; see Weitzman and Kanazawa (1978: Figs. 2, 3, 4, 9, 10) for illustration of this variation in *E. pulcher* and *E. geryi*. *E. pulcher* especially appears to have a dark as well as a light colored phase that may be changed in life; compare Figs. 2 and 3 in Weitzman and Kanazawa (1978). *E. junki* may have a similar ability to change color pattern in life by selective expansion and contraction of dark chromatophores. All specimens from 44 km east of Humaitá have color pattern illustrated in Fig. 3. Detailed examination of Fig. 2 of holotype of *E. junki* reveals traces of color pattern of parallel vertical rows of dark scales clearly shown in Fig. 3; the same is true for the specimen in Fig. 4. This color pattern of parallel vertical rows of darkly pigmented scales in *E. junki* is most like that of *E. geryi*; compare with Figs. 9 and 10 in Weitzman and Kanazawa (1978:174) and see discussion below.

Top of head pale brown, darker from dorso-posterior border of eye to near nape. Snout pale brown dorsally; a prominent dark stripe extends from snout tip and oral border of premaxillary and anterior part of maxillary to anterior border of eye. Anterior tip of lower jaw dark brown. Dark brown chromatophores ventral to eye organized into one or two short vertical bars. Opercle with scattered dark chromatophores apparently somewhat organized according to borders of opercular, preopercular, subopercular, and interopercular bones (Fig. 4). Ventral surface of head pale yellow with small, scattered brown chromatophores.

Caudal fin without vertical bars; interrational membranes with dark chromatophores producing a dusky appearance to fin which in life may be quite dark when chromatophores expanded. Dorsal fin rather evenly dusky with distal parts of interrational membranes quite dark, especially anteriorly, in some specimens (Fig. 2). As in other species of *Elachocharax*, a dark horizontal band present along length of dorsal fin near its base (sometimes indistinct as in Fig. 3); see especially Fig. 4. Anal fin with interrational membranes usually very dark; anal fin probably black in life when dark chromatophores expanded. Pelvic fins with pigment distributed as in anal fin. Pectoral fin dusky, with pigment distributed as in pelvic and anal fins but not as dense as in these fins. Specimens from 44 km east of Humaitá appear to have pale pelvic fins.

### Relationships

The three species of *Elachocharax* are related by the following analysis. Table 2 shows relative primitive and derived states of 12 characters and Fig. 7 is a diagram showing the relationships of the three species and the distributions of the synapomorphies and autapomorphies discussed below. In the

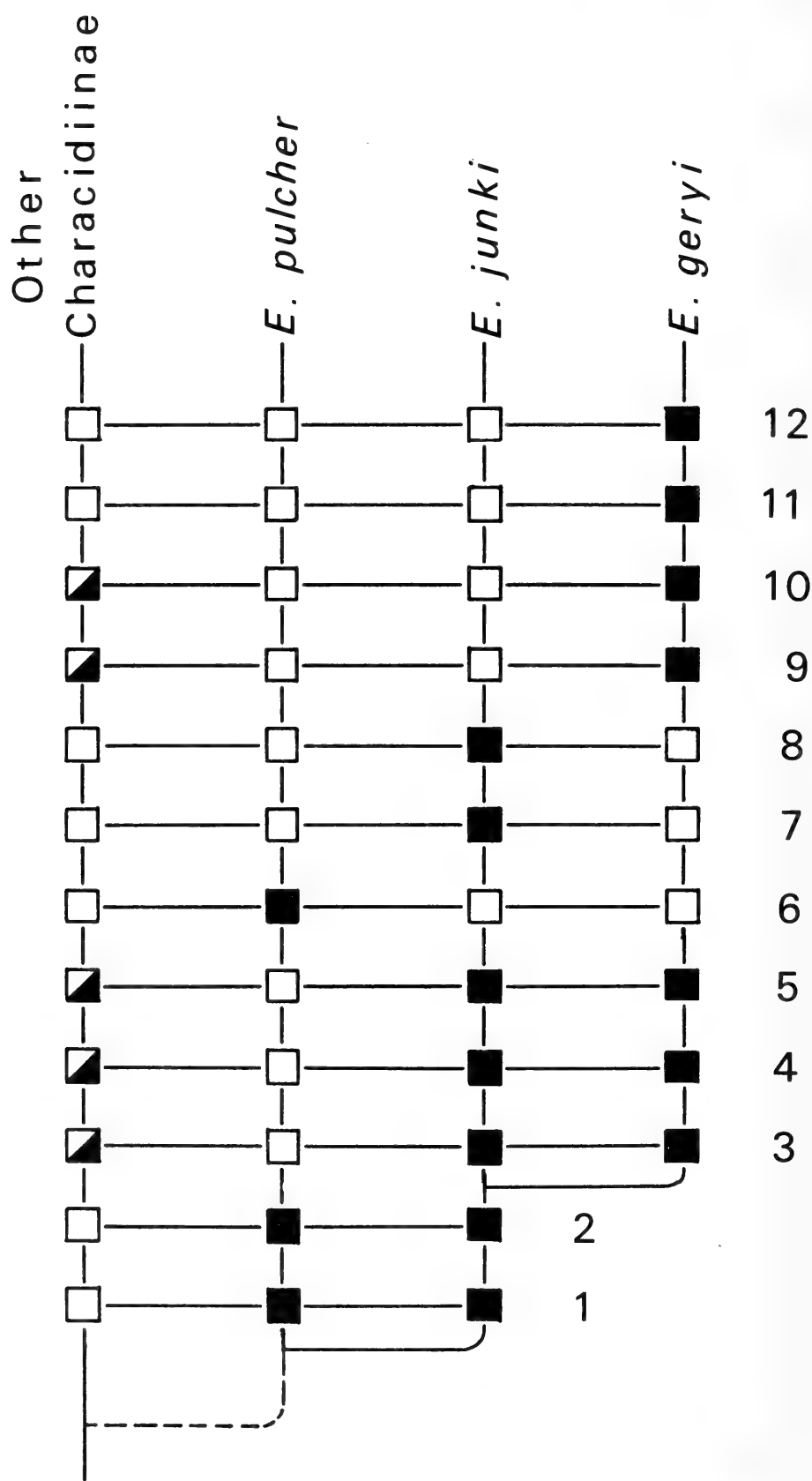
Table 2.—Characters used in synapomorphy and autapomorphy diagram (Fig. 7).

Character	Plesiomorphic (relatively primitive) state	Apomorphic (relatively derived) state
1. Total number of dorsal-fin rays	11 to 14	17 to 22
2. Position of anal-fin origin with respect to dorsal-fin base termination	Anal-fin origin posterior to dorsal-fin base	Anal-fin origin below, very slightly posterior, or in advance of termination of dorsal-fin base
3. Branchiostegal-ray number	5	4
4. Adipose fin	Present	Absent
5. Premaxillary and dentary tooth cusps	Tricuspid	Unicuspid
6. Number of vertical body bars	9 to 12 narrow bars	8 wide bars
7. Number of vertical body bars	9 to 12	16 to 17
8. Position of anal-fin origin with respect to dorsal-fin base termination	Anal-fin origin below posterior termination of dorsal-fin base	Anal-fin origin anterior to posterior termination of dorsal-fin base
9. Number of teeth in inner dentary tooth row	19 to 24	13 to 16
10. Number of ectopterygoid teeth	7 to 24	4 to 5
11. Number of caudal-fin bars	0 to 5	13 to 14
12. Number of epibranchial gill rakers	5 to 6	3

discussion of the polarity of the characters below and in Table 2 and Fig. 7, each character is represented by the same numeral.

1. The number of dorsal-fin rays in *Elachocharax* is 17 to 22. In all other known species of the other genera of the Characidiinae the number of dorsal-fin rays is 11 to 14. By far the greater number of new world characoids have a total of 11 dorsal-fin rays. Thus by outgroup comparison the high number of dorsal-fin rays in the species of *Elachocharax* should be a derived shared character.

2. The reasons for the position of the anal-fin origin, ventral to the posterior termination of the dorsal-fin base, in *Elachocharax* being considered



a uniquely derived character is not as clear as the reasons that the increased number of dorsal-fin rays is a singularly derived condition. The reasons for the acceptance of this character as advanced are as follows. Most characoids including the other Characidiinae have the dorsal fin in advance of the anal fin. It is only in specialized groups such as the Gasteropelecidae, some of the glandulocaudin characids, certain genera such as *Charax*, *Iguanodectes*, *Agoniates*, and *Paragoniates*, that the dorsal fin is over or posterior to the origin of the anal fin. The members of each of these characoid groups share their own unique set of synapomorphies and therefore appear unrelated to the Characidiinae. Thus it is assumed here that the similarity among these groups of the position of the anal fin and the dorsal fin is of independent origin. Two further comments should demonstrate the verity of this statement. In most characoid species or groups with a posteriorly placed dorsal fin such as *Xenagoniates bondi* Myers, the gasteropelecids, and some of the glandulocaudins, the relative position of the dorsal and anal fins has been derived by an increase in the number of anal-fin rays and an anteriorly advanced migration of the origin of the anal fin. In *Elachocharax* the relative position of the dorsal fin and anal fin is correlated with an increase in the number of dorsal-fin rays and a posterior extension of the posterior termination of the dorsal fin over the anal fin, which does not have an increased number of rays. The relative positions of the dorsal fin in *Elachocharax* on the one hand and such characoids as *Xenagoniates bondi*, the species of the gasteropelecids and of the glandulocaudins on the other, are not the same thing. Characters 1 and 2 discussed here are correlated synapomorphies for the species of *Elachocharax*.

The other characters mentioned in the generic description above are not unique to *Elachocharax* and only form a combination which will separate the species of *Elachocharax* from other species of the Characidiinae. We cannot at present offer evidence, pro or con, that the other characters mentioned in the generic description above for *Elachocharax* are independently

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Fig. 7. Synapomorphy and autapomorphy diagram for species of *Elachocharax*. Solid black squares indicate a derived condition, empty squares indicate a plesiomorphic condition and half-black squares indicate the same derived condition as the black squares but indicate an independent origin of that condition. The outgroup line to the left in the diagram labeled "other Characidiinae" represents species of all other genera of the Characidiinae. The use of half-black and empty squares along this left hand line indicates that both plesiomorphic and apomorphic (derived) conditions of the character in question occur in various of these species. When the squares are empty along the outgroup line it means that the derived condition of the character in question is not known outside of *Elachocharax*. Only a broken line is shown joining *Elachocharax* to the "other Characidiinae" and no characters are shown as synapomorphies for the Characidiinae because this problem is only partly treated in this paper.

derived. Many of the characters separating *Elachocharax* are reductive or perhaps labile and therefore may have been repetitively evolved, or altered in similar fashion independently. Such characters appear to be of low value in phylogenetic evolutionary studies, especially at generic and higher taxonomic levels.

The following three derived characters can be used to unite *E. junki* and *E. geryi*, and exclude *E. pulcher*.

3. Branchiostegal rays. Five branchiostegal rays are present in *E. pulcher*. According to Weitzman (1962) five branchiostegal rays appear to be primitive for the Characidae and independent repetitive reductions in branchiostegal rays appear common in characoid fishes. In some groups of characoids, branchiostegal ray counts appear invariable in species and genera, for example, the Lebiasinidae (Weitzman, 1964). On the other hand Weitzman and Kanazawa (1976:330) find that the number of branchiostegal rays can be variable within genera of the Characidiinae and that the number can occasionally vary from one side to the other side of the head of a single specimen. We have not found this kind of variation in *Elachocharax*, but our sample size of *E. junki* and *E. geryi* is small. In any case the occurrence of four branchiostegal rays in *E. junki* and *E. geryi* is a shared derived state within *Elachocharax* and is probably a derived homology and therefore a synapomorphy for these two fishes at this taxonomic level.

4. Adipose fin absent. Again this character is one that is repeatedly and independently lost in a wide variety of characoid groups, frequently disappearing in small or miniature species (Myers, 1958; Weitzman, 1962) and may even be found to be present or absent in individuals of one species of the Characidiinae (Weitzman and Kanazawa, 1977). Within each species of *Elachocharax* the presence or absence of the adipose fin appears stable and therefore within this genus the absence of the fin may be considered a derived state shared by *E. junki* and *E. geryi*.

5. Premaxillary and dentary teeth unicuspid. As in the previous two characters, the presence of lateral cusps is quite variable among characoids. The use of the number of tooth cusps in relating the member species and genera of subfamilies, tribes, and genera in characoids has a long history (see Eigenmann, 1912, 1915, 1917; Myers and Böhlke, 1956; Weitzman, 1964). Such practice may be valid in certain groups of characoids, but it now appears that using this character at traditional generic and family-group levels should be done with caution. For example, Myers and Böhlke (1956) proposed the tribe Xenurobryconini for a group of pygmy characoids apparently related to glandulocaudin characids. One of the characters used to unite the two included genera and separate the Xenurobryconini from the remainder of the glandulocaudins was the possession of unicuspid teeth in the former and tricuspid teeth in the latter. Weitzman and Fink (in prep.) have described a new species of *Xenurobrycon* which in nearly all its characters except the

number of tooth cusps and shape of the enlarged caudal-fin scale is extremely similar to the previously known species, *Xenurobrycon macropus* Myers and P. de Miranda Ribeiro. The new species bears tricuspid and bicuspid teeth as well as unicuspid teeth. In this instance, at least, the nature of the cusps appears useful as a species difference only, rather than at generic or tribal levels. Fewer tooth cusps is a reductive character probably subject to much independent evolution so that the assumption of its homology among characoid taxa and its use as a synapomorphy must be treated with great caution in any given instance. In the genera *Characidium*, *Jobertina*, *Ammocryptocharax* and *Klausewitzia* there are species which have tricuspid teeth in the jaws and others which have only unicuspid teeth. If these genera, as they are currently constituted, are monophyletic groups, it would appear that unicuspid teeth evolved at least four separate times in the Characidiinae, given the assumption that the presence of multicuspid teeth is primitive for the Characidiinae based on an outgroup comparison with other characoids. The presence of species with tricuspid or only unicuspid teeth in *Elachocharax* would make at least a fifth independent occurrence of this derived character in the Characidiinae.

Although we are unable to accept the hypothesis that the loss of tooth cusps is homologous at the currently recognized generic levels in the Characidiinae, we incline to believe that it may be a synapomorphy at the level of relationships in the case under discussion. We favor this position because the three characters discussed immediately above represent congruent synapomorphies and thus "reinforce" one another. No synapomorphies were found to indicate either that *E. pulcher* and *E. geryi* are more closely related to each other than each is to *E. junki*, or that *E. pulcher* and *E. junki* are more closely related to each other than each is to *E. geryi*.

The following series of characters appear to be autapomorphies, derived features allowing separation and identification of the species of *Elachocharax* but providing no information about their relationships.

6. Eight wide vertical bars on body sides. The case for the derived nature of this character is as follows. In most if not all species of the Characidiinae, relatively narrow vertical body bars or large mid-side dark marks are present, usually 9 to 11 or rarely 12 in number. The wide nature and capability of these bars to expand so that the whole body is black or dark brown in *E. pulcher* would seem, by outgroup comparison with the remainder of the Characidiinae, to be a derived state.

7. Sides of body with 16 or 17 narrow vertical body bars. This character, present in *E. junki*, appears to be an increase in the number of body bars in comparison with any other known species within the Characidiinae and is therefore derived. *E. geryi*, with 11 to 12 vertical body bars, is plesiomorphic in this respect.

The above analyses of vertical body bars is not without problems. The

number of vertical body bars in *E. pulcher*, 8–9, overlaps that, 9–11, found in the other characidiin genera. However, the width is apomorphic. In *E. geryi* the number of vertical body bars is slightly higher, 11–12 versus 9–11, than those found in most other characidiin species, and again overlaps the plesiomorphic number. However, the bars in *E. geryi* and *E. junki* remain narrow, a plesiomorphic state.

Two features are found in *E. geryi* which are not present in *E. pulcher* and *E. junki* and at least most of the other species of the Characidiinae.

8. Anal-fin origin anterior to posterior termination of dorsal-fin base. This character is a further derived state of the character discussed under 2 above. The character is autapomorphic for *E. junki*.

9. Inner dentary tooth row with 13 to 16 teeth. *Elachocharax junki* and *E. pulcher* respectively have 19–20 and 20–24 inner row dentary teeth in adults. Weitzman and Kanazawa (1978) reported a single exceptional specimen of *E. pulcher* with 14 inner row dentary teeth. Most other species of Characidiinae have more than 16 teeth in the inner dentary row of adults but some pygmy species such as *Klausewitzia aphanes* have 16 or fewer. It is to be expected that a reduction in tooth row number would evolve independently in separately derived pygmy species.

10. Four to five conic ectopterygoid teeth in a single row. *E. pulcher* has 7–10 and *E. junki* has 8–13 ectopterygoid teeth. Most other species of the Characidiinae have more than eight ectopterygoid teeth and sometimes two or more rows with as many as 24 teeth. Reductions do occur, apparently independently, in other genera. For example, *Klausewitzia aphanes* has 6–8 in a single row and *Ammocryptocharax elegans* varies greatly, having 4–22 in a single row.

Finally *E. geryi* bears a couple of autapomorphic characters which are not found anywhere else in the Characidiinae as far as is known.

11. Caudal fin with 13 to 14 narrow vertical dark bars. There are no more than four or five vertical caudal-fin bars in any other known member of the Characidiinae, and usually there are none. Caudal-fin bars, especially vertical ones, are not found in most characoids.

12. Three upper limb gill rakers. There are five or six upper limb gill rakers in the other species of *Elachocharax* and in the other members of the Characidiinae known to us. There are usually more than six upper limb rakers in other characoids. Therefore a reduction to three may be taken as a derived character for *E. geryi*.

There are a few other differences among the three species of *Elachocharax* but polarity of derived versus plesiomorphic states of these characters was difficult to hypothesize by outgroup comparison. For example, peduncle length was 14.4 to 18.0,  $\bar{x} = 16.5$ ,  $n = 36$  in *E. pulcher*; 16.0 to 19.2,  $\bar{x} = 17.7$ ,  $n = 8$  in *E. geryi*; and 19.2 to 21.9,  $\bar{x} = 20.3$ ,  $n = 6$  in *E. junki*. *Elachocharax junki* has more lateral series scales, 30–33,  $\bar{x} = 31.3$ ,

than either *E. pulcher*, 26–30,  $\bar{x} = 28$ ,  $n = 36$ , or *E. geryi*, 27–29,  $\bar{x} = 27.8$ ,  $n = 8$ . There also appear to be differences in vertebral numbers, 29–31,  $\bar{x} = 30.4$ ,  $n = 62$  for *E. pulcher*; 31–32,  $\bar{x} = 31.5$ ,  $n = 8$  for *E. geryi*; and 32,  $\bar{x} = 32$ ,  $n = 2$  for *E. junki*.

Additional characters were used by Géry (1971) to distinguish *E. junki* at generic (*Geisleria*) and subfamily (Geisleriinae) levels from the Characidiinae and from the Elachocharacinae. As noted in the introduction, of these four taxa the only one recognized here is the Characidiinae. The reasons for the rejection of the two subfamilies are based on the following analysis.

Géry (1971:162, table, and 163, key) in discussing *Geisleria* indicates that *E. junki* has two rows of premaxillary teeth, a “suspected” presence of maxillary teeth, a “suspected” absence of ectopterygoid teeth, a stated absence of “suborbital” bones, and no cranial fontanel. These characters, as presented by Géry, are in error because no alizarin preparation was available. The primary character of those above used by Géry to separate *Geisleria* from *Elachocharax* was the presence of two rows of premaxillary teeth. Géry’s placement was an attempt to be consistent with a classification of other characoids as established by Eigenmann (1915, 1917) wherein the Cheirodontinae were separated from the Tetragonopterinae on the basis of one versus two rows of teeth on the premaxillary bone. Fink and Weitzman (1974) have reviewed the problems associated with basing a classification of characoids at the family-subfamily level on this character. They suggest the character may not be useful at some taxonomic levels in some characoid groups due to independent appearance. However, in the instance of *Geisleria* versus *Elachocharax* the question is moot because the holotype of *Geisleria* does not have a second inner row of premaxillary teeth. The appearance of a second row of teeth is due to thick, very papillose flesh immediately external to the oral valve and just posterior to the prominent row of premaxillary teeth which are firmly ankylosed to the premaxillary bone. Buried in this papillose flesh are some well developed replacement teeth which are not firmly bound to the premaxillary. They are smaller than the anterior teeth and point posteriorly and ventrally in the oral cavity. When the premaxillary teeth of the holotype were first reexamined, two rows of teeth seemed apparent. In part this was due to the well-developed state of the replacement teeth and in part to the outward-thrust position of the premaxillary of the holotype which was preserved with its mouth open and gill apparatus expanded. However, application of an extremely fine jet of air to the region to shrink the flesh somewhat away from the second tooth row revealed that some of the “teeth” deformed and shrank away as papillous flesh. The remaining teeth did not deform but did move with the receding flesh, indicating that they are not firmly attached to the premaxillary bone. This movement is typical of even well developed replacement teeth in characoids. Resoaking the fish in alcohol brought the papillous flesh



and replacement premaxillary teeth back into normal position. Examination of the cleared and stained jaws, orbital bones, palatine and pterygoid arches, opercle, and branchiostegal rays of the right side of the head in the specimen of *E. junki* from the Rio Cuieiras revealed 9 premaxillary replacement teeth posterior to a single row of 14 prominent teeth firmly ankylosed to the premaxillary bone. In Fig. 5 the replacement teeth are posterior to the visible row of teeth and cannot be seen. One tooth has been shed (4th from the right) and was being replaced by a tooth that is not as yet firmly ankylosed to the jaw margin. There is only one row of premaxillary teeth in all the specimens of *E. junki* examined. Weitzman and Kanazawa (1978) report only one row of premaxillary teeth in *E. pulcher* and *E. geryi*.

Similar investigation of the maxillary bone revealed no maxillary teeth in the holotype of *E. junki* and examination of the cleared and stained jaws showed no maxillary teeth. There were no teeth on the left maxillary bone in any of the new specimens. There are no maxillary teeth in *E. pulcher* or *E. geryi*.

There are 8 conic ectopterygoid teeth in nearly a single row on both sides of the holotype of *E. junki* and 11–13 ectopterygoid teeth in the other specimens examined. Weitzman and Kanazawa (1978:168, 175) report a single row of 7–10 unicuspid ectopterygoid teeth in *E. pulcher* and 4–5 in *E. geryi*.

Géry (1971:154) stated that the circumorbital series was very reduced or perhaps even totally absent in *E. junki*. On pages 162 and 163 he states that the suborbitals are absent and uses this as one of the characters to distinguish his Geisleriinae and Elachocharacinae. The suborbitals are usually considered to be circumorbitals two, three, and sometimes the remainder of the posterior orbital series exclusive of the supraorbital and antorbital. Tube-bearing circumorbitals, more properly infraorbitals (see Weitzman, 1962:28 and footnote 7), one and two are present in the holotype of *E. junki* and are moderately well ossified on the right side. They are much less ossified on the left side where they may have been damaged by a greater exposure to acid formalin. These two bones are well ossified and each bears a canal along its entire length in the stained side of the specimen of *E. junki* from the Rio Cuieiras. Infraorbital three and the subsequent infraorbitals four, five, and six appear absent or at least not ossified in the holotype. The bone, if present, did not take up alizarin stain in the specimen from Rio Cuieiras. In all specimens the skin in the area of infraorbital three is thicker and tougher than the skin of other parts of the orbit. At least the specimen of *E. junki* from the Rio Cuieiras was exposed to formalin for about eight months and may therefore have had the bone of this normally thin bony plate dissolved away. No bony canal bone was found in the region of the infraorbitals three to five. In summary, a slender, tubeless antorbital and tube-bearing infraorbitals one and two are present. The "great suborbital" of Eigenmann (1912) (infraorbital three) and all the remaining more posterior

orbitals are either greatly reduced in ossification or absent. The same condition occurs in cleared and stained specimens of *E. geryi* and *E. pulcher* examined for this report.

Another reductive character used by Géry (1971:163) to separate *Geisleria* and *Elachocharax* at the subfamily level was the absence of a cranial fontanel in the former and its presence in the latter. The fontanel is not actually absent in *E. junki* but occurs as a very small opening where the posterior medial borders of the parietals of each side meet the supraoccipital and surround the anterior portion of the supraoccipital fossa. In fishes with this anatomical arrangement a very slender needle can be passed between the parietals and supraoccipital into the brain cavity. In the Characidiinae the posterior cranial fontanel (that part posterior to the epiphyseal bar) is all that remains. Usually this is represented by a separation of the parietal bones from each other along the midline. The resulting fontanel is continuous with and part of the median fossa along the dorsal surface of the supraoccipital spine. Apparently in many species of *Characidium* the parietals are completely separated but in some species (and in some species of *Jobertina*) they contact each other anteriorly, restricting the fontanel to a more posterior position and reducing it in relative size. Near closure of the fontanel is not restricted to pygmy members of the Characidiinae. There is an unidentified species of robust, large (to at least 64 mm SL) relatively high altitude *Characidium* from the Rio Uruyen on the south slopes of Mt. Auyantepuy, State of Bolivar, Venezuela (USNM 219847), which has the parietals completely jointed along their medial borders as in *E. junki*, leaving only the area immediately bordered by the posterior part of the parietals and the supraoccipital as a fontanel. *Elachocharax pulcher* and *E. geryi* have reduced fontanels, the parietals usually being closely jointed anteriorly and not posteriorly. The larger specimens of *E. pulcher* examined by Weitzman and Kanazawa (1978) usually had the fontanel more restricted than the smaller specimens and sometimes it was almost as restricted in *E. pulcher* as in *E. junki*. The extent of the restriction of the fontanel thus seems to vary somewhat with the size of the specimens examined in the instance of *Elachocharax* and a small fontanel is subject to repetitive independent appearance in the Characidiinae.

Géry (1971:163) separated his Elachocharacinae and Geisleriinae on the one hand from his Characidiinae on the other by the former two having a very small size, a long dorsal fin of at least a total of 17 rays and poorly developed pectoral fins. He also noted that the species of these genera apparently live a relatively "secondary" specialized existence in a quiet water habitat whereas Characidiinae live in stream habitats requiring an active existence to resist current. The habitat differentiation is true when compared to the larger species of *Characidium*. However, some other pygmy species such as *Jobertina eleotrioides* Géry and *Klausewitzia aphanes*

appear to live in similar, "quiet" habitats. One of us (Weitzman) has recovered specimens (USNM 221046) of miniature *Jobertina* 13.0 to 14.5 mm standard length from a mass of algae collected by Bruce Collette in a very slow moving stream, Rio Marituba, Pará, Brazil. Meinken (1969) erroneously identified *Klausewitzia aphanes* as *Characidium voladorita* Schultz while describing its swimming habits, indicating that it is a quiet water fish, and Weitzman and Kanazawa (1977) report that aquarium specimens of *K. aphanes* appear adapted to quiet waters. The habitat reported for *K. aphanes* by Weitzman and Kanazawa is a slow moving blackwater stream.

These two fishes, *J. eleotrioides* and *K. aphanes*, also have pectoral fins somewhat elongate in form and with a reduced number of fin rays, like that of the three species of *Elachocharax* recognized here. There is usually a total of 11 fin rays in the pectoral fin of species of *Characidium*. Some species will have one or two less. This is the same count found in most "tetragonopterine" characids and may therefore be primitive for the Characidiinae. In *Characidium* the number of unbranched anterior rays varies from one to four or rarely five. Most "tetragonopterine" characids only have one unbranched anterior pectoral fin ray. The propensity to have two or more unbranched anterior pectoral fin rays in the Characidiinae appears to be a synapomorphy for the Characidiinae. *Elachocharax pulcher* and *E. junki* usually have eight pectoral-fin rays and usually all the rays are undivided, but occasionally one, two or three of the middle rays may be divided, especially in *E. junki*. We found one specimen of *E. pulcher* with seven undivided rays on one side and nine undivided rays on the other. Weitzman and Kanazawa (1978:170) report six to nine rays in this species with very few specimens with any branched rays. Weitzman and Kanazawa (1978:177) report six to eight unbranched rays in *E. geryi*. Two specimens of a *Jobertina*, apparently related to *Jobertina eleotrioides* and 13.0 mm in standard length from Rio Marituba, Pará, Brazil, had eight pectoral-fin rays, the anterior four undivided, the posterior four divided. Two paratypes of *Jobertina eleotrioides* had nine pectoral-fin rays, the anterior four undivided, the posterior five divided. *Klausewitzia aphanes* has a total of eight, rarely nine, unbranched pectoral-fin rays. Furthermore, there is a series of 10 or more undescribed species of miniature to small members of the Characidiinae, mostly from the Amazon basin, which have 10 or fewer pectoral-fin rays. As the genera are currently defined, these species "fit" *Characidium* or *Jobertina*. It appears that a reduced number of pectoral-fin rays and a trend for all of them to be undivided is common in small to miniature Characidiinae regardless of their apparent phylogenetic origin. This character should not be used to define genera and subfamilies within this group, at least not unless further investigation substantiates a hypothesis that all miniature Characidiinae belong to a single monophyletic group.

Thus, of all reasons that Géry (1971) separated the Elachocharacinae and

the Geisleriinae from the Characidiinae, the only characters that we now can find to serve as synapomorphies for their members are the two characters used above and in Fig. 7 to differentiate *Elachocharax* as here defined from the other genera of the Characidiinae.

Géry (1971:163) separated his Elachocharacinae and Geisleriinae on the basis of the following characters: teeth triscupid, uniserial in the premaxillary, pterygoid teeth present, maxillary teeth apparently absent, infraorbitals reduced and with a small posterior cranial fontanel for Elachocharacinae, and teeth conic, biserial in the premaxillary, pterygoid apparently absent, maxillary teeth apparently present, infraorbitals absent and no cranial fontanel for the Geisleriinae. Of all these differences or apparent differences only that of the tooth cusps remains and all the species included by these two nominal subfamilies have uniserial premaxillary teeth, pterygoid teeth present, maxillary teeth absent, infraorbitals 1 and 2 present but the posterior infraorbitals reduced or absent, and with a small to very small cranial fontanel.

As described above, the differences in tooth cusps (the reduction to conic teeth) has been found to be a synapomorphy uniting *E. junki* and *E. geryi*. *Elachocharax pulcher* has the less derived state of tricuspid cusped teeth. This is correlated with two other synapomorphies present in *E. junki* and *E. geryi*, a loss of the adipose fin and a branchiostegal ray number reduced from five to four. To recognize these two species as belonging to a subfamily or a genus separate from *E. pulcher* on the basis of these three synapomorphies seems to us poor systematic practice, especially in view of the fact that these characters could be independent derivations since they are apparently independently derived in other sections of the Characidiinae. *Elachocharax* is then a pygmy genus of the Characidiinae with three known species, of which *E. pulcher* is the least derived and of which *E. junki* and *E. geryi* apparently are related and more derived; *E. geryi* appears the most derived. Table 2 and Fig. 7 give a summary of the characters and suggested relationships.

There is not enough information available to attempt a productive analysis of the relationships of *Elachocharax* to the other genera of the Characidiinae. There is a basic color pattern shared by the species here assigned to *Elachocharax* which does not appear in quite the same form in many other species of the Characidiinae. The pattern of a stripe of dark pigment along the length of the dorsal fin, near its base or at least nearer than half the length of the fin rays toward the base, is shared with *Klausewitzia aphanes*, another miniature species (up to 16.5 mm SL) in the Characidiinae, and in *Characidium surumnense* Steindachner, *Characidium boavistae* Steindachner, and a few other species of *Characidium*. *Klausewitzia ritae* Géry (1965), also of small size (at least 25.0 mm SL), is stated to have two very narrow bands on the dorsal fin. Both species of *Klausewitzia* have a much

shorter dorsal fin and have maxillary teeth. Both of these characters are plesiomorphic to the state found in *Elachocharax*. The latter character, the presence of maxillary teeth, is a presumably plesiomorphic character otherwise found only in the two species of the otherwise specialized genus *Ammocryptocharax*. *Klausewitzia ritae* is probably less specialized than *K. aphanes*, being of larger size and having tricuspid as well as unicuspid teeth (teeth are all unicuspid in *K. aphanes*), in always having an adipose fin (present or absent in *K. aphanes*), and in having a complete lateral line (much reduced in length in *K. aphanes*). *Klausewitzia ritae* needs further study in order to outline more clearly its possible reductive apomorphies in orbital bones and other characters, but of the known species of relatively short-bodied small or pygmy Characidiinae this species appears to be the most primitive.

Some species of *Jobertina* have an increase in the number of dorsal-fin rays, to 14, and some, *Jobertina interruptua* Pellegrin and *Jobertina theagerei* Travassos, have the longitudinal dorsal-fin stripe as found in *Elachocharax*. *Jobertina* and *Elachocharax* (along with *Klausewitzia aphanes*) share a reductive character, a short lateral line of 10 or fewer perforated lateral-line scales. As with most reductive characters, this one is hard to evaluate because of its repetitive independent appearance in miniature fishes. The genus *Jobertina*, for example, separated from *Characidium* on the basis of a lateral line of few perforated scales and a tendency to slightly increase the number of dorsal-fin rays in some species, may be polyphyletic and its members may have arisen more than once from a *Characidium*-like ancestor. The relationships of *Elachocharax* are currently indefinable but may be with certain of the pygmy species of *Klausewitzia* or *Jobertina*.

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### Summary

Based on the characters analyzed here, *Elachocharax* is a genus of the Characidiinae of uncertain relationships. Its species have a relatively short body and a long-based dorsal fin (17–22 rays) with its posterior termination over or posterior to the anal-fin origin. All the known species are miniature, 25 mm or less in standard length. The genus may be most closely related to *Klausewitzia* or to certain members of *Jobertina*. *Elachocharax* consists of three species further characterized by reductions in the orbital bones and other features of the lateral sensory system such as the lateral-line scales of the body. *Elachocharax pulcher* is apparently the least derived and has tricuspid, bicuspid, and unicuspid teeth, usually five branchiostegal rays, and an adipose fin; *E. geryi* and *E. junki* appear more advanced or derived with regard to these characters and have unicuspid teeth, four branchiostegal rays, and no adipose fin. *Elachocharax junki* is the most specialized with regard to the origin of the anal fin which is noticeably in advance of the posterior termination of the dorsal-fin base. This species also has the largest number of body bars, about 17, presumably an advanced condition. *Elachocharax pulcher* may be advanced in a different direction in having a decrease in the number of vertical body bars and a widening of those bars when compared to species in other genera of the Characidiinae. *Elachocharax geryi* may be the least advanced in some of its color pattern, having 11 to 12 vertical body bars, but the most advanced in having many narrow, vertical, caudal-fin bars.

The nominal subfamilies Elachocharacinae and Geisleriinae are rejected, the type species of the latter being considered a species of *Elachocharax* and the Elachocharacinae being recognizable as a member of the Characidiinae at the generic level.

### Resumo

O exame do holotipo e de cinco novos exemplares da espécie nominal *Geisleria junki*, juntamente com uma reconsideração sobre as espécies *Elachocharax pulcher* e *Elachocharax geryi*, permitiu uma reavaliação das subfamílias nominais Geisleriinae e Elachocharacinae, bem como do gênero nominal *Geisleria*, da subordem Characoidei. Ficou evidenciado que alguns

dos caracteres usados por Géry (1971) para separar *Geisleria* de *Elachocharax* e Geisleriinae de Elachocharacinae não apresentam diferenças nestes “taxa” nominais. Todas as espécies anteriormente incluídas nestes “taxa” têm uma única série de dentes premaxilares, dentes no ectopteri-góide, maxilar sem dentes, ossos orbitais com configuração idêntica ou muito semelhante e fontanelas cranianas reduzidas mas distintas. As três espécies aqui consideradas como pertencendo a *Elachocharax*, *E. pulcher*, *E. junki* e *E. geryi*, têm em comum os seguintes caracteres que as separam de outros gêneros de Characidiinae reconhecidos neste trabalho: nadadeira dorsal alongada, com 17 a 22 raios, sua base terminando acima da origem da nadadeira anal, ou ultrapassando-a um pouco. Nos outros Characidiinae ha 11 a 14 raios na nadadeira dorsal e a origem da nadadeira anal é muito posterior à nadadeira dorsal.

Um caráter usado por Géry (1971) para separar *Geisleria* e Geisleriinae de *Elachocharax* de Elachocharacinae—a presença de dentes apenas unicúspides nos primeiros e tricúspides nos segundos—tem sido utilizado para separar famílias, tribos e gêneros em outros grupos de Characoidei. Weitzman and S. V. Fink (no prelo) demonstraram, por exemplo, que em Xenurobryconini o caráter é útil apenas para separar as espécies de um gênero, não tendo portanto utilidade ao nível de tribo. Em Characidiinae, dentes unicúspides podem ter aparecido independentemente em espécies de cinco gêneros: *Characidium*, *Jobertina*, *Ammocryptocharax*, *Klausewitzia*, e agora *Elachocharax*.

Originalmente *Geisleria* foi em parte definido com base na ausência de uma nadadeira adiposa e em caracteres que consideramos no presente trabalho como não pertinentes. Além de não possuir nadadeira adiposa, *Geisleria* pode agora ser definido com base na existência de dentes unicúspides e presença de quatro ao invés de cinco raios branquiostégios. Mostramos que estes caracteres apomórficos surgiram independentemente em outros gêneros de Characidiinae. Parece-nos desnecessário continuar a reconhecer *Geisleria* e *Elachocharax* como gêneros distintos com base na presença de caracteres de redução que podem ter surgido independentemente.

As subfamílias nominais Elachocharacinae e Geisleriinae e o gênero *Geisleria* são rejeitados, a espécie-tipo deste último é considerada uma espécie de *Elachocharax* e Elachocharacinae considerado como membro de Characidiinae ao nível de gênero.

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NEW RECORDS OF *STEREOMASTIS SCULPTA*  
*PACIFICA* (FAXON) (DECAPODA: POLYCHELIDAE)  
IN THE EASTERN PACIFIC OCEAN

Mary K. Wicksten

*Abstract.*—The range of *Stereomastis sculpta pacifica* is extended south from Peru to Chile. Adults are reported for the first time from southern California. The larvae, taken in midwater trawls, reach a length of 87 mm. All but two of the adults measured over 70 mm. The large size of the larvae relative to the adults suggests that much of the life cycle is spent in midwater zones.

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The deep-sea lobster *Stereomastis sculpta pacifica* is one of the most striking decapods occurring at bathyal depths in the eastern Pacific Ocean. The bright scarlet larvae have inflated, globose carapaces unlike those of other midwater decapods in the area. The adults are recognizable by their long chelipeds, flattened, hirsute carapace, and eyes without pigment.

In 1978, Paul Gregory and other biologists of the California Department of Fish and Game brought two specimens of these lobsters to the Allan Hancock Foundation for identification. Examination of the animals suggested that other polychelids in local collections might belong to the same species. I found more specimens in the midwater collections of the Allan Hancock Foundation and at Scripps Institution of Oceanography. Adults were taken in sablefish traps, otter trawls, and beam trawls. Larvae were collected in Isaacs-Kidd midwater trawls.

New records of *S. sculpta pacifica* extend its range south from Peru to Chile, and north from off San Clemente Island to off Point Conception, California. This paper presents new records, discusses the synonymy of the species, and comments on its life history.

*Stereomastis sculpta pacifica* (Faxon)

Fig. 1

*Polycheles sculptus pacificus* Faxon, 1893:196-197; 1895:122-123, pl. C, fig. 1, 1a.

*Eryonicus caecus*?—Faxon, 1893:197-198; 1895:110-111, pl. B, fig. 2; pl. 29, fig. 2-2f.

*Eryoneicus Agassizi* Bouvier, 1915:2.

*Stereomastis sculpta pacifica*.—de Man, 1916:5, 8.—Firth and Pequegnat, 1971:16, 71-72.

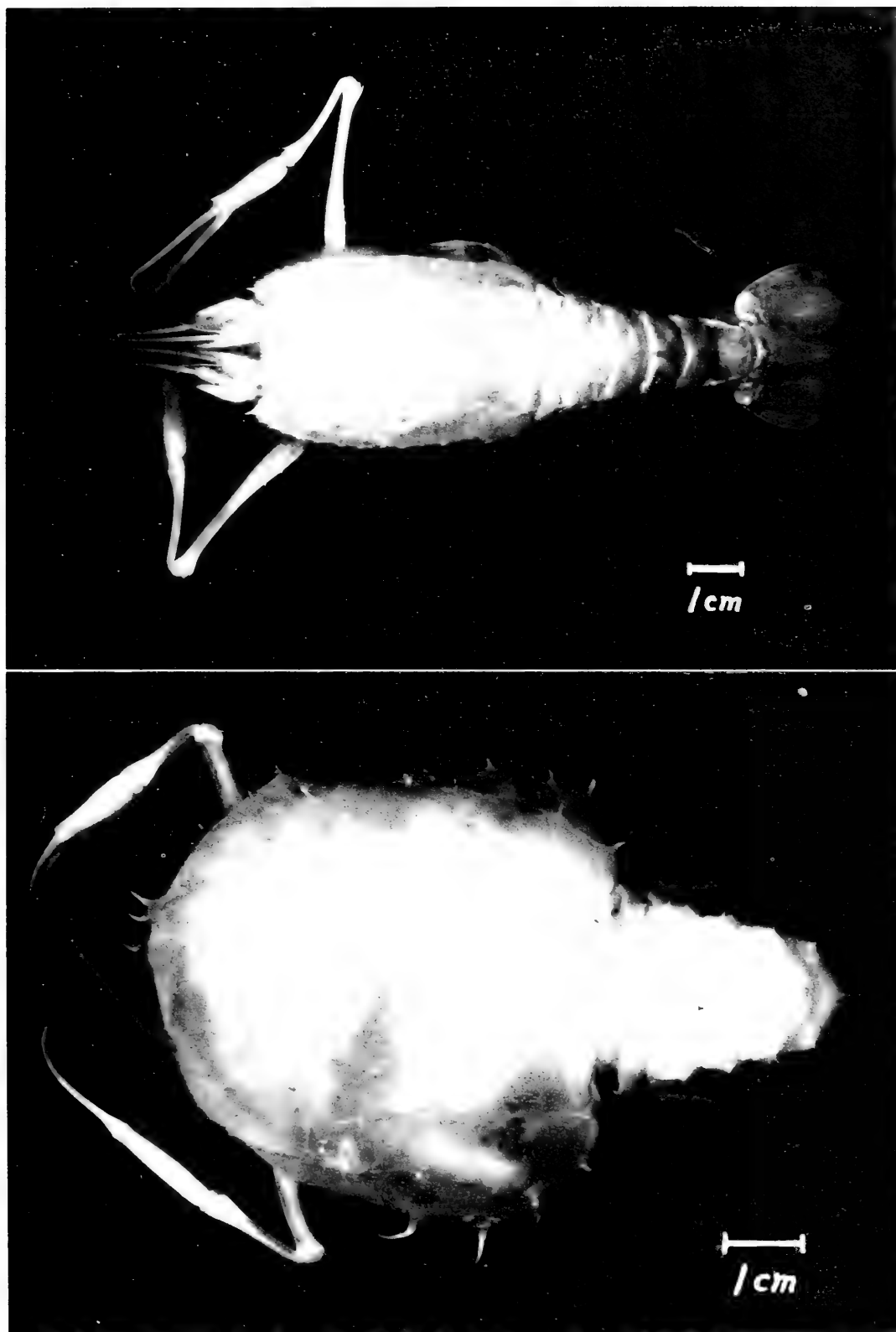


Fig. 1. *Stereomastis sculpta pacifica*. **Upper:** adult female, total length 102.5 mm. Off Baja California, Mexico (31°59.6'N, 118°47.4'W), 1,100 m, boat *Calafia*. **Lower:** larva, total length 87.0 mm. 34.3 mi. from Morro Hermosa, Baja California, 3,720–3,785 m, *Velero IV* sta. 11522.

*Eryoniscus agassizi*.—Schmitt, 1921:105–107, pl. 15, figs. 1–2.

*Polycheles sculptus*.—del Solar, 1972:11.

Not *Pentacheles Agassizi*.—A. Milne-Edwards, 1880:65–66 (= *Polycheles typhlops* Heller).

*Previous records*.—U.S.A.: 2.9 miles, 72°S of east point, Northwest Harbor, San Clemente Island, California (approximately 33°0'N, 118°40'W), 1,207–1,300 m, 9-foot Tanner beam trawl, 9 April 1904, *Albatross* station 4405. MEXICO: Near Las Tres Marias Islands (21°15'0"N, 106°23'0"W), 1,248 m, gray sand, black specks, *Globigerina* ooze, 18 April 1891, *Albatross* sta. 3424. Off Acapulco (16°33'0"N, 99°52'30"W), 1,218 m, brown sand, black specks, 11 April 1891, *Albatross* sta. 3419. PANAMA: Gulf of Panama (7°21'0"N, 79°35'0"W), 943 m, dark green mud, 10 March 1891, *Albatross* sta. 3394. Gulf of Panama (7°21'0"N, 79°2'0"W), 3,382 m, 8 March 1891, *Albatross* sta. 3383. Gulf of Panama (7°15'0"N, 79°36'0"W), 1,883 m, green mud, 10 March 1891, *Albatross* sta. 3393. Off Mariato Point (7°6'15"N, 80°34'0"W), 1,283 m, green mud, 23 February 1891, tow net, *Albatross* sta. 3353. Gulf of Panama (7°6'0"N, 79°48'0"W), 0–738 m, tow net, 9 March 1891, *Albatross* sta. 3388. Gulf of Panama (7°5'30"N, 79°40'0"W), 2,345 m, hard bottom, 10 March 1891, *Albatross* sta. 3392. COLOMBIA: Off Malpelo Island (3°56'0"N, 81°40'15"W), 1,410 m, 5 March 1891, *Albatross* sta. 3377. Cocos Island–Malpelo Island (2°34'0"N, 82°29'0"W), 2,217 m, surface tow net, 4 March 1891, *Albatross* sta. 3375. PERU: North of Callao (10°45'S, 78°36'W), 870 m, 1970–1972, *SNP-1* transect 7105. Off southern Peru (18°23'S, 71°13'W), 1,100 m, 1970–1972, *SNP-1* transect 7201.

Note: Faxon, 1895, as *Eryonicus caecus*? and *Polycheles sculptus pacificus*; Schmitt, 1921, as *Eryoniscus agassizi*; del Solar, 1972, as *Polycheles sculptus*.

The range given by Firth and Pequegnat (1971), “off Panama and the Galapagos Islands, 934 to 2,323 m,” is incorrect.

*Material examined*.—U.S.A.: SW of Point Conception, California (34°30'N, 120°35'W), 923–1,108 m, sablefish trap, 10 May 1979, boat *Arista*, 1 adult. 11 miles, 235°T to W end, Santa Catalina Island (33°26'0"N, 118°51'30"W to 33°21'42"W), 1,302 m, 23 June 1964, *Velero IV* sta. 9852, 1 larva. 13.2 miles, 188°T from W end, Santa Catalina Island (33°20'25"N, 118°47'20"W to 33°10'15"N, 118°31'15"W), 1,228–1,278 m, 25 July 1964, *Velero IV* sta. 9876, 1 larva. 24.5 miles from SE point, San Nicolas Island (33°8'20"N, 119°12'35"W to 32°50'15"W, 118°53'35"W, 1,643 m, 14 May 1964, *Velero IV* sta. 9661, 1 larva. 26.5 miles, 120°T from Aero Light, San Nicolas Island (32°52'30"N, 118°59'20"W to 33°05'0"N, 119°11'0"W), 1,588–1,735 m, 26 February 1969, *Velero IV* sta. 12726, 1 larva. CHILE: Off Arica (18°40.5'S, 70°36.0'W), 768–968 m, 25-foot otter trawl, 7 May 1972, *Thomas Washington* sta. MV72-II-27, 1 adult. Off Arica (18°42'S, 70°37'), 1,097–

1,152 m, 7 May 1972, 25-foot otter trawl, *Thomas Washington* sta. MV72-II-26, 1 adult. Off Valparaiso (30°46'S, 81°31'W), 3,000 m, 4 March 1969, *Piquero* trawl 2, 1 larva. Also an additional 32 adults from 20 stations; Costa Rica, Mexico, and southern California, 750–1,875 m; and 86 larvae from 63 stations; Costa Rica, Mexico, and southern California.

*Total lengths of adults.*—41.3–102.5 mm.

*Total lengths of larvae.*—16.9–87.0 mm.

*Size distribution of larvae.*—10–20 mm (n = 9); 20–30 mm (n = 7); 30–40 mm (n = 35); 40–50 mm (n = 10); 50–60 mm (n = 9); 60 mm or greater (n = 19). Undetermined (n = 2).

*Depth distribution of larvae.*—1,846 m or less (n = 39); 1,846–2,748 m (n = 15); 2,748–3,692 m (n = 28); 3,692 m or greater (n = 3); not recorded (n = 4).

*Remarks.*—Larval stages of polychelid lobsters have been called species of *Eryoneicus* or *Eryoniscus*. Bouvier (1915, 1917) noted that the eastern Pacific species, which he named *Eryoneicus Agassizi*, was different in its spination from *Eryonicus caecus*, taken by the *Challenger* expedition off the Canary Islands (Bate, 1888). Although he saw the similarity between *S. sculpta pacifica* and his *Eryoneicus Agassizi*, he considered the two to belong to distinct genera. Balss (1925) finally established that the large, open-water animals actually were larval polychelids. The generic names *Eryoneicus* and *Eryonicus* have been placed on the Official Index of Rejected Names and the generic name *Stereomastis* validated under the plenary powers (ICZN Opinion 702, 1964). Faxon (1895) considered the genus *Stereomastis* Bate 1888 as being a synonym of *Polycheles* Heller 1862. De Man (1916), however, thought that they were distinct based on their epipodites and the spination of the carapace.

Studying the life history of an animal living at bathyal depths is difficult. The eggs of the female taken off Baja California (Fig. 1) measure approximately 1 mm in diameter. The smallest larval stages have not been collected by the Isaacs-Kidd midwater trawl, which has a liner mesh of 3 mm. The size distribution of the larvae suggests that there may be at least five larger larval stages before settling.

The larvae were collected with myctophid fishes, cephalopods, sergestid shrimps, and other nektonic animals. Like these animals, larval polychelids may migrate vertically. Remains of a bony fish were found in the oral field of one larva.

All but two of the adults measured over 70 mm in total length. The other two measured 41.3 and 47.6 mm each. Nineteen of the larvae were 60 mm or greater in length. The small difference between most of the adults and the largest larvae suggests that maturity is reached soon after settling, perhaps after only one or two molts. The two very small adults indicate that not all the lobsters settle at the same size.

Little is known of the habits of adult *S. sculpta pacifica*. Faxon (1895) reported them from soft bottoms. Four specimens were caught on or inside traps for sablefish (*Anoplopoma fimbria* [Pallas]) baited with chopped fish. The lobsters may have been trying to scavenge on the fish. Wenner (1979) found foraminiferans and parts of crustaceans, fish and polychaetes in the stomachs of *S. sculpta sculpta* Smith, the Atlantic subspecies.

Wenner and Boesch (1979) found that *Stereomastis sculpta sculpta* occurred at 575–2,130 m in the western Atlantic Ocean. Most individuals were taken at 600–1,200 m, at 3.4–10.5°C. This depth range is similar to that of *S. sculpta pacifica*. At 1,300–2,400 m in the Atlantic, they reported *Stereomastis nana* (Smith) to be more abundant than *S. sculpta*. In the eastern Pacific, *S. nana* has been reported off Colombia and the Galapagos Islands (Faxon, 1895). It also has been taken off Chile (32°51'S, 72°8'W, 2,580 m, beam trawl, 19 December 1965, *Anton Bruun* Cruise 12, one specimen, Scripps Institution of Oceanography, unpubl. data). At depths greater than 2,400 m in the eastern Pacific, the lobsters *Willemoesia pacifica* Sund, *Willemoesia challengerii* Sund, and *Willemoesia inornata* Faxon have been collected.

The life history of *S. sculpta pacifica* is unusual for a decapod in having such large open-water larvae relative to the adults. Perhaps it is not surprising that earlier writers did not immediately recognize the midwater forms as larvae. Much of the lifespan may be spent in midwater zones. The catches of nektonic shrimp, fishes, cephalopods, and other invertebrates in the trawls with the larval polychelids suggest that food may be more abundant in the midwater zones than on the bottom. Spending a long time in the open water may aid these lobsters in avoiding competition for food and/or predation on the bottom.

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## THE IDENTITY OF THE FROG *EUPSOPHUS* *VANZOLINII* FROM RAMADILLAS, NAHUELBUTA RANGE, SOUTHERN CHILE

J. R. Formas

*Abstract.*—The frog *Eupsophus vanzolinii* is shown to be a species of the genus *Alsodes*. The species is redescribed on the basis of 38 fixed specimens, and natural history notes on the species are presented.

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Donoso-Barros (1974) described a new species of leptodactylid frog, *Eupsophus vanzolinii*, on the basis of specimens from Ramadillas (73°15'S, 37°15'W), at 100 m elevation on the western slope of the Nahuelbuta Range, Arauco Province, Chile. Little comment has been made concerning the systematic status of this species, although Lynch (1978) transferred *E. vanzolinii* to the genus *Alsodes* on the basis of specimens collected by W. E. Duellman in Cabrería (73°7'S, 50'W), Parque Nacional Nahuelbuta, 1,030 m elevation, Malleco Province, Chile. The air line distance between these points is 65 km.

I analyzed the frogs collected by Duellman in Cabrería, which Lynch (1978) considered *Alsodes vanzolinii*, and the specimens found by Donoso-Barros in Ramadillas, and concluded that the frogs of the two places are different species.

The frogs from Cabrería were previously identified as *Eupsophus coppingeri* (= *Alsodes monticola*) (Iturra and Veloso, 1975), and as *E. vanzolinii* (Duellman and Veloso, 1978). Grandison (1961) used the name *Eupsophus coppingeri* (= *Alsodes monticola*) for the following frogs from Cabrería: Chicago Natural History Museum 44210-44214, 44216-44219, Cabrería, 800 m, Nahuelbuta, Angol; 40136, Nahuelbuta, Angol. According to my colleague Alberto Veloso, the frogs of Cabrería are a new species which is now being described by him.

As a result of the study of the specimens collected by Donoso-Barros in Ramadillas I conclude that *Eupsophus vanzolinii* Donoso-Barros, 1974, must be transferred to the genus *Alsodes* because the males have spiny excrescences on the thumb and chest, the distal edge of the xiphisternum is notched, the nasal bones are large, the cultriform process is long and the anterior end extends between the palatines.

### Redescription of *Alsodes vanzolinii*

#### Fig. 1

*Diagnosis.*—*Alsodes vanzolinii* is a moderate sized species that can be distinguished from its congeners by the following combination of characters:



Fig. 1. Holotype of *Alsodes vanzolinii* (Donoso-Barros), MUZUC 12063, female.

1) rudiment of web between the fifth and fourth toes; 2) thinner limbs; 3) notched tongue covered by minute papillae; 4) yellow triangle on the head.

*Description (based on 38 fixed specimens).*—Head slightly wider than long. Snout rounded and sometimes truncate in lateral and dorsal profile; canthus rostralis well defined; loreal region flat, sloping abruptly to lip; lips not flared. Nostrils lateral, closer to tip of snout than to orbit; length of eye greater than the distance between eye and nostril; interorbital distance greater than internarial distance. Tympanum absent. Well developed glandular fold from behind eye to insertion of arm. Large cordiform tongue, notched behind, covered by minute transparent papillae, posterior one-third free. Relatively small, round choanae; dentigerous process of prevomers lying median to and slightly below choanae, separated medially, transverse or slightly oblique, each process bearing 4–6 teeth. Forelimbs thin; first finger equal in length to second; third finger much longer than fourth; digital length in decreasing order 3-4-2-1. Palmar webbing absent (Fig. 2a); tips of fingers slightly expanded. Large elliptical and prominent inner palmar tubercle; outer palmar tubercle ovoid and smaller than inner; subarticular tubercles moderate sized, conical, and simple; supernumerary palmar tubercles present. Hind limbs slender, tibiotarsal articulation reaching to middle of eye. Toes long (Fig. 2b), slender and fringed; third and fifth toes equal in length; toes in decreasing order of length 4-(3,5)-2-1. Outer metatarsal tubercle ovoid and flattened, inner metatarsal tubercle small and conical. Subartic-



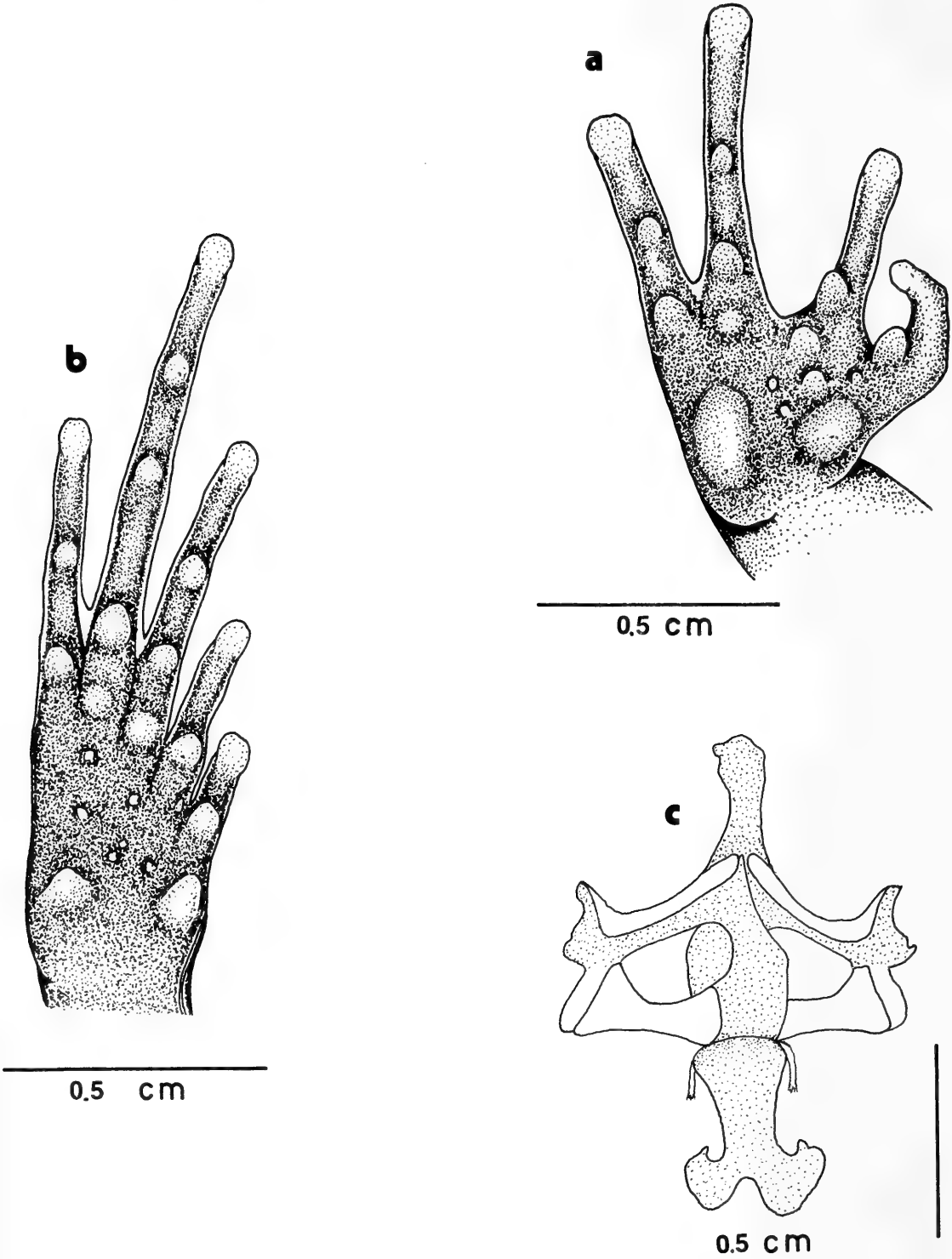


Fig. 2. Hand (a), foot (b), and pectoral girdle (c) of *Alsodes vanzolinii*.

Table 1.—Measurements (mm) and proportions of *Alsodes vanzolinii*.

Character	15 males		13 females	
	Range	$\bar{x} \pm SD$	Range	$\bar{x} \pm SD$
Snout-vent length (SVL)	36.4–52.2	46.2 $\pm$ 5.4	42.7–54.4	51.1 $\pm$ 3.8
Tibia length/SVL	.50–.59	.53 $\pm$ .02	.49–.55	.51 $\pm$ .01
Foot length/SVL	.48–.61	.54 $\pm$ .03	.50–.56	.53 $\pm$ .01
Head length/SVL	.35–.42	.38 $\pm$ .01	.33–.41	.36 $\pm$ .02
Head width/SVL	.38–.43	.40 $\pm$ .01	.37–.42	.39 $\pm$ .01
Interorbital distance/head width	.22–.28	.24 $\pm$ .02	.22–.28	.25 $\pm$ .04
Eye-nostril/head length	.22–.32	.26 $\pm$ .02	.24–.31	.27 $\pm$ .02

ular tubercles large and conical; minute supernumerary tubercles present. Tarsal fold present and reduced. Rudiment of web between fifth and fourth toes. Anal opening oriented transversely, at dorsal level of thighs, and inconspicuously ornamented.

Skin smooth, minute tubercles on flanks, dorsum and head; posteroventral areas of thighs with tuberculate skin. Dorsum brown with irregular whitish spots; head with a yellow triangle. Venter usually whitish, but some specimens show a dark background with minute irregular spots; juveniles have black mottled belly with irregular white spots. Throat whitish, loreal region dark. Dark brown glandular fold behind the eyes. Some specimens have a white vertebral line that reaches to the middle of the back. Arms, shanks, thighs and tarsi barred dark brown.

Variation in proportions is summarized in Table 1.

Osteology

*Pectoral girdle*.—The pectoral girdle is arciferal (Fig. 2c). Clavicles arched and not in contact medially, tips extending anteriorly to a line between the anterior edges of the scapulae. Clavicles in contact with the *pars acromialis* but not overlying it. Scapula proximally bicapitate. Coracoids dilated at their distal and proximal ends and slightly wider than the clavicles. Epicoracoidal cartilages free. Procoracoids fused anteromedially and laterally to the clavicle. The large omosternum has no endochondral ossification and the manubrial portion is well defined. Sternum well developed; the proximal and medial regions show ossification. Metasternum and xiphisternum well differentiated. Distal edge of xiphisternum notched.

*Cranial osteology*.—The nasal bones are large but not in median contact and are separated from the frontoparietals (Fig. 3a). Nasals have long maxillary processes which do not contact the maxillae; margins of nasals rest on the anterolateral margin of the sphenethmoid. Frontoparietal fontanelle narrow at posterior end and wide at anterior part. Anteriorly, the fronto-

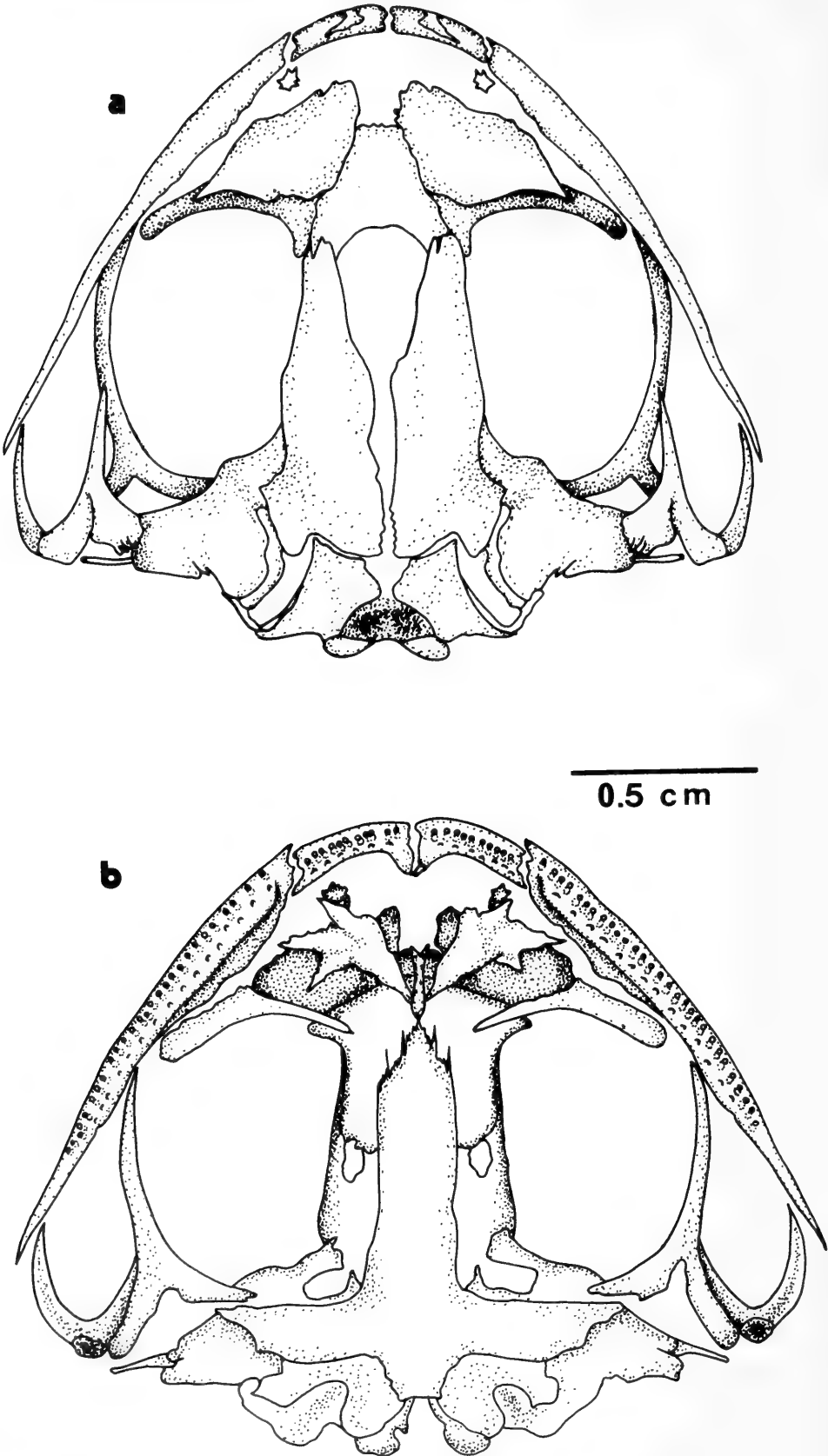


Fig. 3. Skull of *Alsodes vanzolinii*: dorsal (a) and ventral (b) view.

parietals broadly rest on the posterolateral margin of the sphenethmoid; posteriorly they rest on the otoccipitals. Maxillary arch complete. Premaxillae narrow, the alary processes of moderate length and directed dorsally. The 14–15 premaxillary teeth moderately long; *pars palatina* narrow, but the palatine process moderate sized. *Pars facialis* of the maxilla relatively deep and restricted to the snout. Maxilla bears 42–44 teeth in a row extending to a point just posterior to the maxillo-pterygoid junction. Quadratojugal of moderate size and broadly articulating with the maxilla. Otoccipital poorly ossified with low epiotic eminences. Occipital condyles (Fig. 3b) not stalked and narrowly separated. Columela present. Zygomatic ramus of squamosal of moderate length; otic ramus short, broad at distal end, and not in contact with the *crista parotica*. Parasphenoid cruciform. Cultriform process long, gradually narrowing anteriorly, the anterior end extending slightly between the palatines. Parasphenoid alae oriented at right angle to the cultriform process. Anterior ramus of pterygoid rests on the palatal shelf of the maxilla, but does not reach the palatines. Palatines broad and arched, extending from the maxillae to the sphenethmoid. Prevomers small and broadly separated.

### Natural History

Donoso-Barros (1974) considered the holotype of *Alsodes vanzolinii* a male; however, my examination shows that this specimen (MUZUC 12063, Donoso-Barros's field number 4938) has yellow ovarian eggs. All the females examined that have been collected during January and February have moderate sized eggs ( $\bar{x} = 2.33 \pm 0.15$  mm diameter); 134 immature ovarian eggs were counted in one female (MUZUC 12216). Adult males found during these months have nuptial spines on the chest and on the dorsal surface of the thumb and second finger.

The type locality (Ramadillas) is highly disturbed by human intervention, there being only small patches of the primitive *Nothofagus* forest. In this place we also collected *Bufo rubropunctatus*, *Rhinoderma darwinii*, and *Telmatobufo venustus*.

### Comparisons

*Alsodes vanzolinii* shows a rudiment of web between the fifth and fourth toes. This characteristic is also present in *Alsodes nodosus* (Cei, 1962) and *A. monticola* (Formas, personal observation). Webbing is absent in *A. il-lotus* (Gallardo, 1962). *Alsodes gargola* (Gallardo, 1970), *A. laevis* and *A. montanus* (Cei, 1962) share well developed interdigital webbing. *Alsodes vanzolinii* and *A. nodosus* have minute transparent papillae on the tongue, but this character is absent in *A. monticola*; the tongue of the latter species does not have papillae anteriorly.

*Alsodes nodosus* has 65.8 mm snout-vent length (25 adults) differing in this respect from *A. vanzolinii* (54.4 mm, 28 adults). On the other hand, *Alsodes nodosus* have robust limbs, which are slender in *A. vanzolinii*. Finally, *A. vanzolinii* has a yellow triangle on the snout, which is absent in *Alsodes nodosus*.

### Specimens Examined

**Abbreviations.**—University of Kansas Museum of Natural History (KU), Museo de Zoología, Universidad de Concepción (MUZUC), Instituto de Zoología, Universidad Austral de Chile (IZUA).

*Alsodes montanus*: IZUA 823–24; Estero Covarrubias, Provincia Santiago, 2,400 m.

*Alsodes monticola*: IZUA 1149–1154; Cordillera Pelada, Provincia Valdivia, 1,020 m.

*Alsodes nodosus*: IZUA 747–761, 767–776; Aguas Claras, Provincia Aconcagua, 150 m.

*Alsodes vanzolinii*: MUZUC 12063–70, 12209–18, 12221, 12223–25, 12227–28, 12231–44; Ramadillas, Provincia Arauco, 100 m.

*Alsodes* sp.: KU 162206–09, 162212, 162221–22, 162229, 162232; Cabrerías, Parque Nacional Nahuelbuta, 1,030 m.

### Acknowledgments

I am grateful to Tomas Cekalovich (University of Concepción) and William Duellman (University of Kansas) for making specimens available for me for study, and to the latter for providing field notes on the frogs. Sonia Lacrampe typed the manuscript. This work was supported by Proyecto de Investigación S-79-3, Dirección de Investigación, Universidad Austral de Chile.

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THE STATUS OF THE CENTRAL AMERICAN  
LEPTODACTYLID FROGS *ELEUTHERODACTYLUS*  
*MELANOSTICTUS* (COPE) AND *ELEUTHERODACTYLUS*  
*PLATYRHYNCHUS* (GÜNTHER)

Jay M. Savage and James E. DeWeese

**Abstract.**—*Eleutherodactylus melanostictus*, a species unique to the genus in lower Central America in having dark transverse bars on the anterior, dorsal, and posterior surfaces of the thighs, is redefined. *E. platyrhynchus* is conspecific with *melanostictus*. In external and skeletal morphology the species seems allied to the *unistrigatus-cruentus* series. Jaw musculature (dfsq + e) allies this species to the *fitzingeri-rugulosus* series, whereas all known representatives of the *unistrigatus-cruentus* stock have a very distinctive set of jaw muscles (DFSQ<sub>d</sub>AT + s). Karyologically the species has  $2N = 22$ , N.F. = 36 and resembles several members of the *fitzingeri-rugulosus* series, especially *E. berkenbuschii* of eastern Mexico. Known members of the *unistrigatus-cruentus* series have  $2N = 26, 32, 34$ ; N.F. = 32, 36, 46. These differences make *E. melanostictus* the sole representative of a monotypic species group.

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Among the numerous species of rain frogs, genus *Eleutherodactylus*, found in the cordilleras of Costa Rica and western Panama, is a series of populations distinctive from all others in having transverse dark bars on the anterior, dorsal, and posterior surface of the thighs. In life the contrasting light interspaces on the posterior thighs range from cream through yellow-green to orange, salmon, magenta, and scarlet to make these animals among the most conspicuous forms in the genus. Several names have been applied to the populations—including *Hylodes brocchi* Boulenger, 1882 (Günther, 1900), now known to be restricted to Guatemala (Savage, 1975); *Lithodytes melanostictus* Cope, 1875; and *Hylodes platyrhynchus* Günther, 1900 (Dunn, 1937; Taylor, 1952), each based on Costa Rican frogs.

Prior to 1960 these frogs were known from a few individuals from scattered localities. While the problem of the status of the various samples has been recognized for some years, it is only now that sufficient material has been accumulated to make a review of the populations possible.

Comparison of Populations

Frogs of the *melanostictus-platyrhynchus* population system are found along the slopes of the cordilleras of Costa Rica and western Panama, from

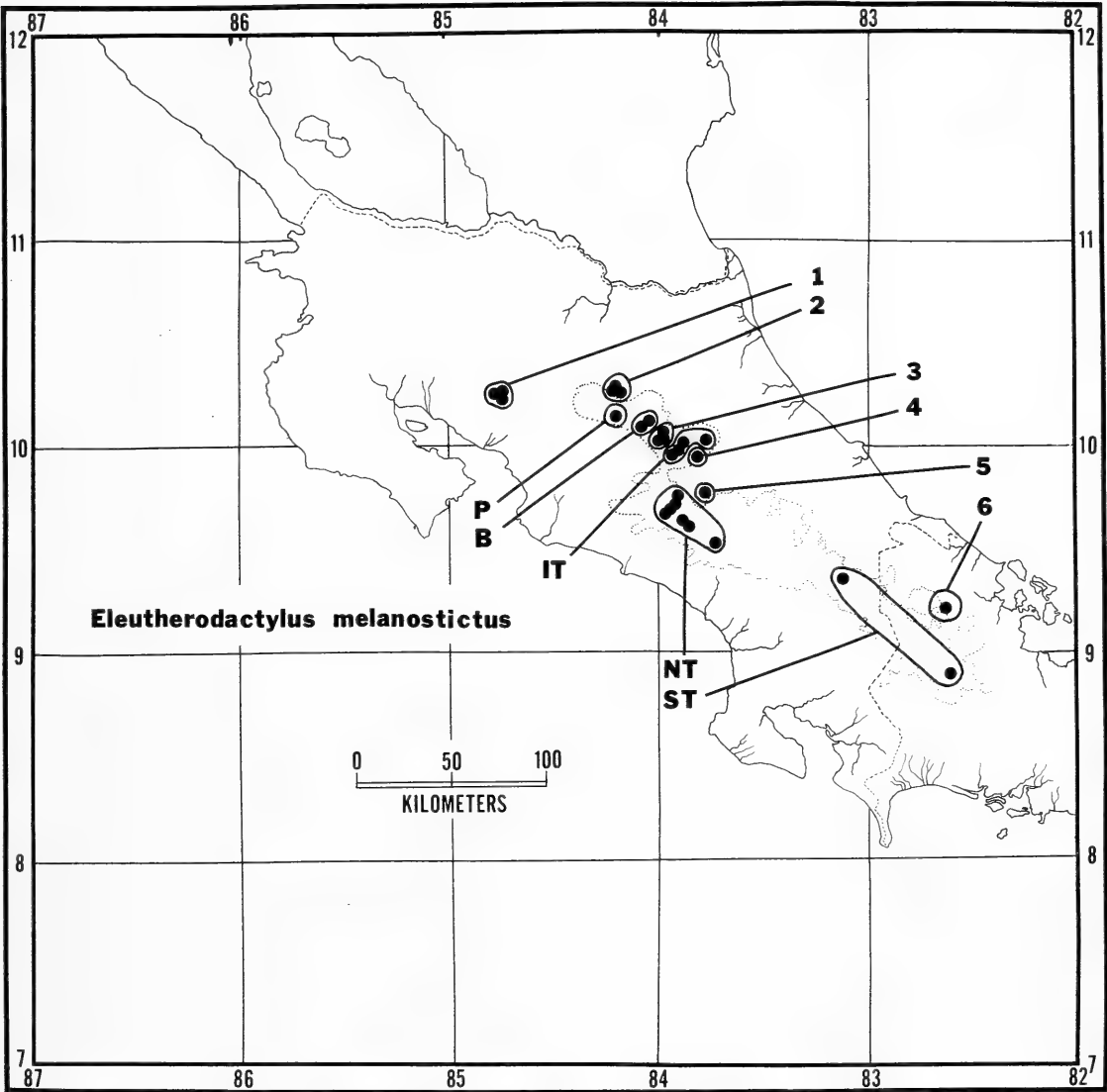


Fig. 1. Distribution of *Eleutherodactylus melanostictus* in Costa Rica and western Panama. Arabic numerals and letters indicate population samples discussed in text. The dotted line indicates the 1,500 m contour.

Monteverde de Puntarenas on the north to the slopes of Volcan Chiriqui to the south, between 1,150 and 2,483 m. Although these creatures are extremely similar to one another in most features of morphology, seemingly significant differences between montane (1,900–2,483 m) and slope (1,150–1,920 m) populations in coloration that correlated with minor morphological distinctions led us to regard them as separate species (Savage, 1976). As additional collections were made the supposed differences became less clear and we decided to undertake a sample by sample comparison to verify or refute our tentative conclusion.

The available material of this system has been grouped into a series of 11 populations (Fig. 1). Slope populations are designated by Arabic numerals,



montane populations by letters. The original comparisons (and greatest recorded differences) were made between the slope population (3) on the pass between volcanes Barba and Irazu of the Cordillera Central of Costa Rica (La Palma–La Hondura pass) and the montane population (NT) on the Cordillera Talamanca along the Carreterra Interamericana in the same country. These differences are summarized below:

Population 3	Population NT
1. Snout obtuse, sloping in profile	1. Snout rounded in profile
2. Disk on finger II expanded, palmate; larger than tympanum	2. Disk on finger II barely expanded, round; smaller or equal to tympanum
3. Subarticular tubercles projecting	3. Subarticular tubercles flattened
4. Toe disks expanded, palmate, II–IV emarginate; largest at least as large as tympanum	4. Toe disks barely expanded, II–IV not emarginate; largest smaller than tympanum
5. Throat and venter usually light, with scattered punctations	5. Throat and venter dark, heavily pigmented
6. Light interspaces on posterior thigh surfaces yellow, yellow-green, purplish, or orange in life	6. Light interspaces on posterior thigh surfaces scarlet in life
7. Groin uniform or with two obscure light spots	7. Groin with well-developed dark bars

It seemed likely that if these differences were maintained with some consistency geographically and/or altitudinally, that two species were involved. For this reason we carefully compared all other populations for these features as follows from northwest to southeast.

1) Cordillera de Tilaran (1,500–1,580 m): snout round to obtuse, sloping; disk on finger II expanded; subarticular tubercles projecting; toe disks expanded; throat and venter light to dark; light thigh interspaces yellow to orange; groin not barred (N = 14).

P) Volcan Poas (2,100 m): snout rounded; disk on finger II small, round; subarticular tubercles flattened; toe disks small; throat and venter dark; thigh color not known; groin barred (N = 13).

2) East slope of Volcan Poas (1,200–1,590): snout round to obtuse, sloping or rounded; disk on finger II expanded; subarticular tubercles projecting; toe disks expanded; throat and venter light; light thigh interspaces yellow to magenta; groin not barred (N = 24).

B) Volcan Barba (1,828–1,920 m): snout round; disk on finger II small, round; subarticular tubercles intermediate; toe disks expanded; throat and venter dark; thigh color not known; groin barred (N = 5).

3) La Palma–La Hondura Pass (1,150–1,500 m): see summary above (N = 25).

IT) Volcanes Irazu and Turrialba (2,000–2,374 m): snout rounded; disk on finger II small; subarticular tubercles flattened; toe disks small; throat and venter dark; light thigh interspaces scarlet; groin uniform (N = 7).

4) South slope of Volcan Irazu (1,600 m): snout obtuse, sloping; disk on finger II expanded; subarticular tubercles projecting; toe disks expanded; throat and venter light; light thigh interspaces yellow, groin uniform (N = 2).

5) Tapanti (1,280–1,320 m): snout obtuse, sloping; disk on finger II expanded; subarticular tubercles projecting; toe disks expanded; venter intermediate in dark pigmentation; thigh color not known; groin not barred (N = 2).

NT) Northern Cordillera de Talamanca (1,900–2,482 m): see summary above (N = 7).

ST) Southern Cordillera de Talamanca (2,135–2,160 m): snout obtuse, sloping; disk on finger II rounded; subarticular tubercles flattened; toe disks expanded; venter intermediate in pigmentation; light thigh interspaces yellow; groin not barred (N = 2).

6) Slope of Cerro Pando (1,200 m): snout rounded; disk on finger II small, palmate; subarticular tubercles projecting; toe disks expanded; venter intermediate in pigmentation; thigh interspace color unknown; groin with a single bar (N = 1).

These comparisons indicate that montane populations from Volcan Poas (P), volcanes Irazu and Turrialba (IT), and the northern Talamanca region (NT) are essentially similar. Populations from the Cordillera de Tilaran (1) and the passes (2, 3) and slopes (4) of the Cordillera Central and northern Talamanca range (5) are almost identical to one another. Some overlap in snout profile and ventral coloration occurs between the three montane samples and the five populations from lower elevations. Nevertheless, it is possible to divide the material into two altitudinal groups based on these eight samples, a montane group from 2,000 m and above and a slope sample from 1,150 to 1,600 m, which differ principally in disk size, nature of the subarticular tubercles and presumably in posterior thigh color. Unfortunately these differences break down in the remaining population samples, one (B) from an intermediate elevation (1,828–1,920 m) on Volcan Barba and the others (ST, 6) from the southern portion of the Cordillera de Talamanca axis in Panama.

The Barba sample consists of three adult males (CRE 6463, 7094, 7130A) and a juvenile (CRE 7130B). In general coloration they agree with other montane examples in having dark venters and barred groins. Morphologically they further resemble montane members of the complex in having the disk on finger II round and small and the subarticular tubercles somewhat flattened, but not as much as in other montane populations. The toe disks, however, are somewhat larger than in other montane individuals and approach the size typical of slope populations.

The southern Talamanca sample consists of two examples, the holotype of *Lithodytes melanostictus* Cope and a single adult female from the vicinity of Cerro Punta, Provincia de Chiriqui, Panama (2,160 m). The female type

(USNM 30608) of *melanostictus* is now in very poor condition, so most characteristics cannot be determined. The Cerro Punta example agrees with montane samples in all characteristics except that the snout is obtuse in profile, the venter is not heavily pigmented, and the light thigh interspaces were yellow in life.

A single female (KU 114851) from the lower northern slope of Cerro Pando (1,200 m) also has a mixture of features. The finger disk size resembles those in montane samples, although larger. The shape of the finger and toe disks and the size of the latter approach those in other slope populations. The ventral coloration is intermediate.

Several possible interpretations may be made based on the available materials: 1) the Cordillera de Tilaran–Cordillera Central populations and the Cordillera de Talamanca samples represent two allopatric races or species; 2) the montane and slope populations represent related but distinct species differing only in the size of disks; or 3) only a single species is involved.

Alternative 1 does not seem valid, since the differences between montane and slope samples from each cordillera is greater than between the cordilleras and no feature will consistently separate available material into two geographic groups. Alternative 2 also seems contraindicated, since both montane and slope populations overlap to some extent in all characteristics except disk size and the Barba sample, from an intermediate elevation, is intermediate between the two groups in this feature.

Alternative 3 seems to be the only tenable conclusion based on this analysis. While montane and slope populations may be separated most of the time on the basis of disk size, subarticular tubercle profile, and coloration, we see no need to formally recognize altitudinal races within the complex. Many of the apparent differences may represent ecotypic influences associated with temperature related responses during development. Theoretically, at least, it is easier to conceive of the similarities among the isolated high elevation populations as the result of such influences rather than the result of fragmentation of a formerly continuous population. This idea implies that each montane isolate is more closely related to the adjacent slope population than to other montane members of the system. The single recognizable species including the eleven populations compared above is:

*Eleutherodactylus melanostictus* (Cope, 1875)

Fig. 2

*Lithodytes melanostictus* Cope, 1875:109, pl. 23, fig. 10.

*Hylodes melanostictus*.—Brocchi, 1881:56.—Günther, 1900:236.

*Hylodes platyrhynchus* Günther, 1900:230, pl. 67, fig. a (holotype: BM 1905-7-18, 1/1947.2.15.81; Costa Rica).



Fig. 2. *Eleutherodactylus melanostictus*: **upper**, male, CRE 7048-1, from 0.5 km W Bajo La Hondura, Provincia de San Jose, Costa Rica; **lower**, female, CRE 3895, from Monteverde, Provincia de Puntarenas, Costa Rica. Photographs courtesy of James L. Vial and James E. DeWeese.

*Hylodes brocchi*.—Günther (in part), 1900:236, pl. 68, figs. a–b.

*Eleutherodactylus melanostictus*.—Dunn, 1937:163.—Taylor, 1952:728.

*Eleutherodactylus platyrhynchus*.—Taylor, 1952:757, fig. 34.

*Holotype*.—USNM 30608, adult female, 50 mm in standard length; from Costa Rica, Provincia de Limon, Canton de Talamanca, Cerro Utyum, 2,135 m.

*Diagnosis*.—A moderate sized *Eleutherodactylus* (males to 43, females to 57 mm in standard length), immediately distinguished from all other species in lower Central America by having distinct dark thigh bars that continue down onto the posterior thigh surface. *E. melanostictus* belongs to a cluster of species placed in the *cruentus* group by Savage (1976) that have large finger and toe disks and a granulate venter and that lack both webbing and a tarsal fold.

The only two species within the group with which *melanostictus* might be confused, *E. cruentus* and *E. cerasinus*, have numerous accessory palmar tubercles on the hand and are much smaller in size (*cruentus* males to 25, females to 38 mm; *cerasinus* males to 23, females to 35 mm). The posterior thigh surface of *cruentus* is usually uniform dark brown to black, often with some clear yellow spots; the posterior thigh surface of *cerasinus* is almost uniform dull red in life (brown in preservative) with a very few small light spots in some examples.

*Description*.—Head outline from above subovoid to subelliptical; snout profile rounded to obtuse (sloping) in profile. Canthus rostralis sharp. Loreal area obtuse, slightly concave in section. Choanae small, ovoid, smaller than vomerine tooth patches; vomerine tooth patches transverse, posterior but internal to choanae, very narrowly separated on midline. Paired vocal slits and single internal vocal sac in males. Surfaces of head mostly smooth, with a single large supraorbital tubercle near posterior edge of upper eyelid, a series of weak superciliary tubercles along margin of upper eyelid and several smaller tubercles elsewhere on eyelid. Tympanum round in males, oval in females; internal, indistinct in both sexes, vertical diameter about  $\frac{1}{2}$  length of orbit. A distinct supratympanic fold. Dorsum and upper limb surfaces relatively smooth with scattered tubercles. Finger I shorter than II; disk on finger I rounded. Disks well developed on fingers III–IV, at least 2 times width of digit, larger than tympanum, emarginate; disk on finger II slightly to definitely expanded, usually palmate. Whitish nuptial pad on thumb of adult males. Subarticular tubercles of fingers ovoid, flattened to slightly projecting, globular in profile; no supernumerary tubercles; thenar tubercle large, elongate; palmar tubercle large cordate, no accessory palmar tubercles. A distinct calcar. Toe disks smaller than finger disks, largest about equal to disk on finger II; disks on toes II–IV truncate to palmate, emarginate; disks on toes I and V very slightly expanded. No webbing. Subarticular tubercles under toes ovoid, slightly projecting and globular in

profile; no supernumerary tubercles; no plantar tubercles; inner metatarsal tubercle well developed, elongate, outer indistinct very small, round; no tarsal fold, but a very weak series of small outer tarsal tubercles may be present. A distinct small gland in groin; venter granulate.

*Coloration.*—Dorsal ground color pale tan to dark brown, in life brown, chestnut olive, olive-green or green; head uniform above or with distinct light (pink in life) enamel area on anterior surface of snout; dark brown to black interocular bar in most examples, sometimes bordered anteriorly by an obscure light area; usually a distinct dark canthal blotch extending from eye to nostril and involving upper loreal zone; a distinct black supratympanic stripe from eye to behind tympanum; tympanum covered by a dark spot; four distinct to obscure dark lip bars, the first continuous with the canthal blotch; two bars separated by a light area lie below eye. Iris golden in life, with a greenish cast. Five principal dorsal color patterns: i) essentially uniform with a few dark blotches and/or short lines on suprascapular and flank areas, sometimes with a definite W-shaped suprascapular dark mark; ii) with a broad mid-dorsal stripe, as broad or broad as interorbital area, contrasting in color with flanks and usually demarcated by an irregular narrow dark boundary; in life the center stripe is chestnut to reddish-brown; iii) with a narrow distinctly light (scarlet to yellow in life) mid-dorsal stripe, about half width of interorbital space, bordered by a black outline; stripe begins at interorbital or suprascapular region and continues to anus; iv) very narrow tan mid-dorsal stripe along median raphe, continuing as a narrow light longitudinal stripe on posterior thigh surface; and v) with distinct to obscure dark blotches and/or chevron-shaped marks dorsally. Flanks marked with a series of dark elongate oblique dark blotches, outlined by black, to give impression of a tiger pattern. Dark areas often flecked with metallic green, magenta or gold in life. Upper surfaces of forelimbs uniform to strongly barred with dark. Dorsal, anterior and posterior surfaces of thigh and calf marked with distinct dark bars; primary dark bars and light interspaces about same widths, although interspaces often split by a very narrow dark stripe; light interspaces on upper and anterior surfaces of thigh and calf suffused by darker pigment; on posterior thigh surface interspaces clear light and usually very distinct in most examples, although sometimes suffused with darker pigment; in life light areas on posterior surface are bright yellow, yellow-green, orange, salmon-pink, magenta, or scarlet. Throat and venter and undersides of limbs range from dirty white (in life and preservation) through intermediate stages to being heavily marked with dark pigment; in some examples dark pigment forms distinct dark spots. Groin area usually uniform like flank, sometimes with two obscure light spots or with elongate dark blotches similar to those on the flank in the tiger pattern phase. In life, light areas of groin and adjacent surfaces of venter and hindlimbs may be suffused with orange, pink, or red.

Table 1.—The centromeric indices (C.I.) and percent genome values (G) for the 11 pairs of chromosomes in the karyotype of *Eleutherodactylus melanostictus*.

Chromosome number	C.I.	G
1	1.37	16.9
2	1.47	13.4
3	4.07	12.1
4	2.04	11.9
5	1.15	9.8
6	1.26	8.8
7	1.28	7.0
8	7.00	6.6
9	7.00	5.1
10	7.00	4.6
11	7.00	3.7

*Measurements.*—In this section the notation gives the mean followed by the range in parentheses. Standard lengths (distance from snout to vent) are given in millimeters, other measurements as percentages of standard length. Values are based on samples of 10 adult males and 10 adult females randomly selected from montane and slope populations. The smallest juvenile available is 12 mm in standard length. Standard length, adult males 38.2 (35.0–42.6), adult females 43.8 (35.4–56.3); head length, males 38.0 (36.2–40.0), females 37.7 (34.0–39.5); head width, males 41.3 (38.4–45.6), females 40.9 (39.0–42.4); snout length, males 16.6 (15.0–18.3), females 16.9 (14.5–18.2); loreal length, males 11.1 (10.3–12.4), females 11.6 (9.0–13.0); length of orbit, males 16.2 (14.5–18.0), females 14.6 (12.8–17.2); height of tympanum, males 6.5 (5.0–7.9), females 6.1 (4.5–7.0); hindlimb length, males 199.1 (185.0–222.2), females 205.8 (168.0–225.2); tibia length, males 62.2 (54.1–76.4), females 62.3 (51.0–68.1). No marked sexual dimorphism is evident from these measurements, although the relative tympanum heights are slightly distinctive.

*Karyotype.*—Bogart (1970) described the karyotype of a specimen referred to this species from Monteverde, Costa Rica. We have karyologically examined one example (CRE 4130), a female, from near Cerro Punta, Panama, using the technique of Patton (1967) as modified by Lowe *et al.* (1966). 7 spreads were counted, 3 were photographed and the individual chromosomes were measured (Table 1).

The diploid number (2N) is 22 and the *nombre fundamental* (N.F.) is 36. The chromosomes form a gradually descending series with no obvious size groupings. Chromosome pairs (centromere placement according to the system of Levan *et al.*, 1964) 1, 2, 5, 6 and 7 are metacentric; 4 is submetacentric; 3 is subtelocentric; and 8–11 are acrocentric (Fig. 3).



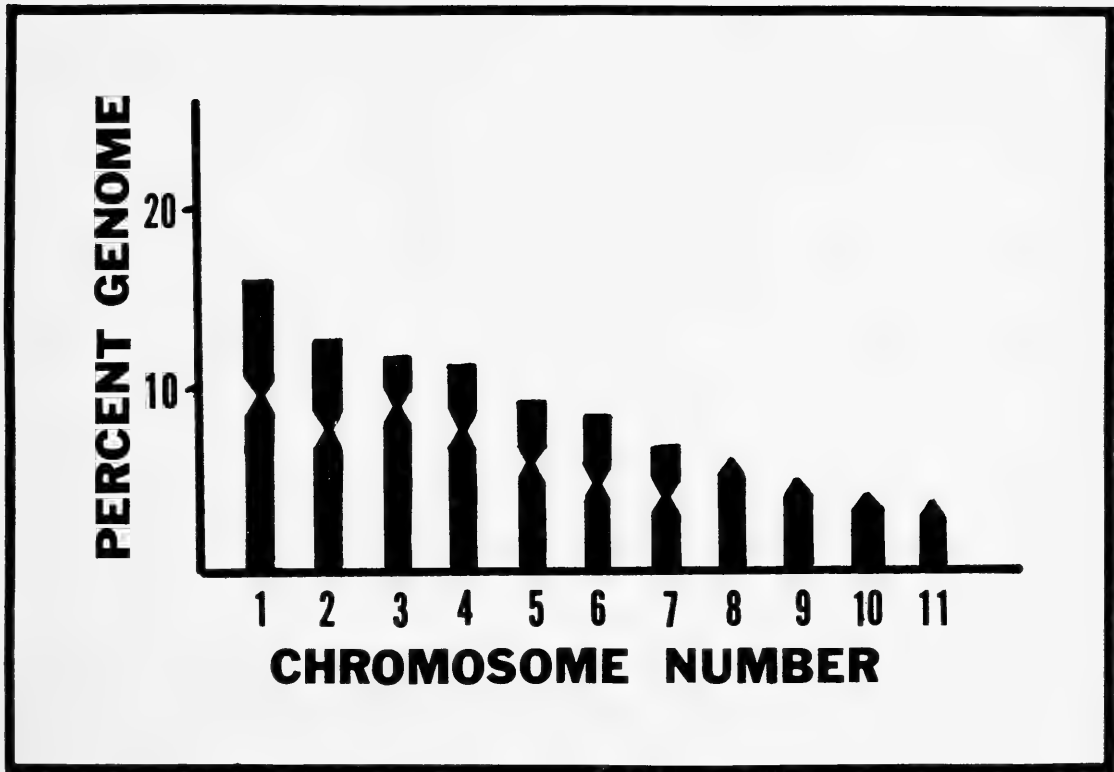


Fig. 3. A representative idiogram for *Eleutherodactylus melanostictus*.

Bogart's (1970) description and figure differ slightly from our data, with  $2N = 22$  and  $N.F. = 38$ . Chromosome pairs are 1, 5, 6 and 8 metacentric; 3 and 4 submetacentric; 2 and 11 subtelocentric; and 7, 9 and 10 acrocentric, according to Bogart. Essentially his interpretation is that there is one less acrocentric and one more subtelocentric pair, one less metacentric and one more submetacentric and that 11 is subtelocentric rather than acrocentric. This latter interpretation or observation explains the difference in  $N.F.$  between Bogart's example and our data. These apparent differences may be due to 1) differing techniques of preparation and measurement of the spreads; 2) variation, either individual or populational; or 3) misidentification of the Monteverde specimen by Bogart. Although we have been unable to locate Bogart's voucher specimen to confirm the identification, *E. melanostictus* is so distinctive in color pattern that the last alternative seems unlikely. Until additional karyological preparations are available, no decision between the other two alternative explanations is possible.

*Jaw musculature.*—The depressor mandibulae has a single slip originating on the dorsal fascia with a few fibers coming from the squamosal (dfsq). The adductor mandibulae externus superficialis is present (e). The jaw muscle formula  $dfsq + e$ , follows the terminology of Starrett (1968).

*Ecological notes.*—Taylor (1952:761) reported the collection of a number



of examples of this form from bromeliads, where they may hide during the day. Most specimens in our samples (La Palma, La Hondura and Monteverde) are males taken at night while calling from herbaceous vegetation 1.0–2.5 m above the ground in dense rainforest habitats. USC examples from the Talamanca range are mostly males found under rocks or logs during the day.

*Distribution.*—Evergreen forests of the upper portion of the premontane and lower montane zones on both Atlantic and Pacific slopes of the Cordilleras de Tilaran, Central, and Talamanca of Costa Rica and the extension of the latter as the Chiriqui massif of western Panama, 1,128–2,483 m (Fig. 1).

*Locality records.*—COSTA RICA: no other data; ALAJUELA: Isla Bonita; Hda. Cayuga; Cinchona; above Cinchona (1,590 m); E slope Volcan Poas (1,590 m) 1 km W Poasito, Rio Poasito; CARTAGO: 1.6 km NE Casa Mata; 2.5 km W Sanatorio Duran, Volcan Irazu; El Empalme and 16 km S; 2 km NW Pastora, Volcan Turrialba; Volcan Irazu (2,000 m); Rio Quiri, Tapanti; nr. El Sesteo; 1–2 km SE Santa Teresa; Trinidad; CARTAGO–SAN JOSE: 1 km S El Empalme; Cerro de la Muerte; HEREDIA: Volcan Barba (1,828 m); Cerro Chompipe; LIMON: Cerro Utyum (2,135 m); PUNTARENAS: 1.75, 2.6 km ESE, 1.25, 2.25 km SE and Monteverde; SAN JOSE: Boquete Camp; La Hondura; 0.5 km W Bajo La Hondura; 2 km E Las Nubes; 0.5 km E, N, S and La Palma; 1.4 km S Alto La Palma; 3 km SE and Rancho Redondo. PANAMA: BOCAS DEL TORO: N slope Cerro Pando (1,200 m); CHIRIQUI: 2 km W and 0.5 km N Cerro Punta.

*Remarks.*—We have examined holotypes of both *Lithodytes melanostictus* and *Hylodes platyrhynchus*. The former (USNM 30608) is now in very poor condition and some of the features noted when it was examined 14 years ago by Savage are no longer distinguishable. The distinctively barred thighs are still apparent and all other characteristics and the original description (Cope, 1875) confirm its identity with the montane populations of the Cordillera Talamanca–Chiriqui axis of Costa Rica and Panama.

Günther (1900:226, 236) ascribed a smooth ungranulated venter to this specimen, doubtless based on Cope's (1875:109) statement "skin everywhere smooth." Cope probably was referring to the upper surfaces of the body. However, the rugosely granulate venter of this and many other *Eleutherodactylus* is distorted in poorly fixed specimens or those long in preservative.

The type of *Hylodes platyrhynchus* (BM 1905-7-18, 1/1947.2.15.81) remains in excellent condition. It is an adult female 57 mm in standard length and morphologically agrees in all ways with the sample (3) from the pass between Volcanes Barba and Irazu. The dorsal color pattern is of type i) described above. The head markings and thigh barring as illustrated by Günther (1900, pl. 67A) confirm the identification.

The most consistent and distinctive characteristic of *E. melanostictus* is the continuation of the dark thigh bars onto the posterior surface of the thighs. Since the light interspaces between the dark bars are usually brightly colored in life, the contrasting dark versus brilliant yellow, yellow-green, orange, magenta, or red makes this species readily recognizable in the field. Two examples here referred to this species exhibit a considerable reduction and suffusion of the light interspaces with dark pigment to obscure the usually contrasting pattern. An adult male (CRE 3296), 37 mm in standard length, from near Bajo La Hondura, Costa Rica, has the light interspaces reduced to several small light spots while the margins of the dark bars are obscured by the suffusion of dark pigment. On close inspection the typical dark thigh bars may be observed. This example also has the throat, venter and undersides of limbs heavily covered with dark pigment, a condition unusual in other examples of *E. melanostictus* from this locality. As a matter of fact it has the greatest degree of ventral dark pigmentation within all samples of this species. In all other features this frog agrees with our concept of the species and we conclude that it is a variant with much more extensive development of melanin than is usual.

A second extremely dark example of this form is an adult female (CRE 3985), 56 mm in standard length, from Monteverde, Costa Rica. In all features but coloration this example is a typical *E. melanostictus*. Essentially, the Monteverde frog has a very dark dorsum and extensive dark pigmentation over all the under surfaces. The light interspaces on the thigh surfaces are very heavily suffused with dark so that the dark thigh bars appear outlined by a very narrow light line. The extensive dark suffusion makes the dark bars obscure on the posterior thigh surface, since even the bordering remnant of the interspaces is lost as the bar proceeds downwards. The bars are barely distinct from the heavily suffused interspaces in this region, but can be distinguished by their heavier concentration of black pigment.

### Relationships

Evaluation of evolutionary relationships among the multitudinous species of *Eleutherodactylus* has long defied the capabilities of herpetologists. Most attempts to group clusters of the 400 or so nominal species now placed in the genus have been based primarily on external "key" characteristics of dubious aid in discerning all but the most closely related species similarities. Recently Savage (1976) and Lynch (1976) have applied two somewhat different approaches to establishing divisions within *Eleutherodactylus*. The former recognized species groups comprised of species that are extremely similar morphologically and are probably evolutionarily closely allied. Lynch follows a second alternative of forming groups that correspond to sub-genera, without giving them formal nomenclatural status. Both methods

have thus far proven inadequate to cope with the complex mosaic of superficial morphological characteristics that have been combined over and over again in distantly related species of *Eleutherodactylus* for the reasons already pointed out by us (Savage and DeWeese, 1979).

The, for the most part, unpublished studies on jaw musculature (Starrett, 1968), serum proteins (Harris, 1973) and karyology (DeWeese, 1976) of *Eleutherodactylus* suggest that at least six major evolutionary lineages are recognizable within the limits of the genus (*sensu lato*). In most cases these lineages do not conform to the groupings recognized by Lynch (1976) based on external and skeletal morphology. That the problem is real is suggested by the fact that Savage (1976) included *E. melanostictus* in the *melanostictus* group, its synonym *platyrhynchus* in the *cruentus* group; Lynch (1976) regarded the latter taxon as belonging to his *unistrigatus* group in which he included *cruentus* and its allies.

*Eleutherodactylus melanostictus* morphologically, but apparently only superficially, resembles the members of the *cruentus* group (Savage, 1976) in having a strongly granulate venter, large digital disks, and no toe webbing or tarsal fold. Other Central American species included in this group by Savage are: *altae*, *pardalis*, *cruentus*, *cerasinus*, *ridens*, *frater*, *caryophallaeceus*, *moro* and *monnichorum*. Studies by DeWeese (1976) on the karyology of most of these forms and the less extensive serum protein data of Harris (1973) indicate that the *cruentus* group is a composite of species from rather diverse origins that happen to share a series of trivial morphologic features in common. Lynch (1976) included all of these disparate forms among the 92 species placed in his *unistrigatus* group.

In terms of jaw muscle features, *E. melanostictus* shows the greatest similarity to the *fitzingeri* and *rugulosus* groups of Savage (1975, 1976), which are included together in the *fitzingeri* group of Lynch (1976). As pointed out by Starrett (1968) the most consistent and evolutionarily significant of these muscles is the condition of the adductor mandibulae. Three conditions may be recognized: 1) both an adductor mandibulae posterior subexternus and an externus superficialis present (s + e); 2) only the posterior subexternus present (s); or 3) only the externus superficialis present (e). *Eleutherodactylus melanostictus*, like the members of the *fitzingeri-rugulosus* groups now examined from Central America, has the e condition. All known members of the *unistrigatus* group of Lynch (1976) have the s condition.

In addition, the features of the depressor mandibulae of *E. melanostictus* support a similar relationship. Starrett (1968) recognized 10 patterns of depressor mandibulae muscle origins. Six of these conditions occur within the family Leptodactylidae and four are known to occur in *Eleutherodactylus*. These conditions are: 1) a single slip principally from the dorsal fascia, but with a few fibers from the squamosal (dfsq); 2) a single slip principally from the dorsal fascia, but with a few fibers from the squamosal and annulus

tympanicus (dfsqt); 3) three slips, one each from fascia, squamosal and annulus tympanicus (DFSQAT); and 4) three slips, with superficial slip from fascia and annulus tympanicus and a deep slip (internal to the others) from the squamosal (DFSQ<sub>d</sub>AT). We regard conditions 1 and 2 as representing only slight variation in a single character.

The depressor mandibulae in *E. melanostictus* are of condition 1 (dfsq). This condition is typical of the *fitzingeri-rugulosus* groups of Savage (1976). Some species in this complex (*brocchi* and *rugulosus*) have condition 2 (dfsqt). All members of the *unistrigatus* group of Lynch (1976) for which this character is known have condition 4 (DFSQ<sub>d</sub>AT).

Karyologically, *E. melanostictus* agrees in diploid number ( $2N = 22$ ) and N.F. (36) with *E. talamancae* of Costa Rica and Panama, *E. berkenbuschii* (recently revived by Savage and DeWeese, 1979) and *E. vocalis* of Mexico, and *E. rayo* of Costa Rica, all members of the *fitzingeri-rugulosus* complex. Other leptodactylids with the same numbers are *E. decoratus* (*alfredi* group) and *Hylactophryne augusti* (of Mexico); and *Leptodactylus podicipinus*, and *L. wagneri* of South America. Of these species the chromosome features of *E. melanostictus* most closely approach those of *E. berkenbuschii*. Members of the *cruentus* group of Savage (1976) and the *unistrigatus* group of Lynch (1976) for which the karyology is known have  $2N = 26, 32, 34$  and N.F. = 32, 36, 46 (Bogart, 1970; DeWeese, 1976).

What a dilemma! A frog that in external and skeletal morphology clearly belongs with one major section of the genus (the *unistrigatus-cruentus* stock), but in extremely important features of jaw musculature and karyology belongs elsewhere (*fitzingeri-rugulosus* complex)! Obviously our knowledge of this marvelously complex and perverse genus is far from complete. It may be that *E. melanostictus* represents a primitive stock ancestral to the two very distinctive major groups (*unistrigatus-cruentus* and *fitzingeri-rugulosus*). Full investigation of this possibility awaits more extensive data on jaw musculature and karyology. Until these studies are completed it seems wise to retain *melanostictus* in a distinct monotypic group.

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critical live specimen for karyological analysis. P. H. Starrett confirmed the condition of the jaw musculature for *E. melanostictus*. Our work in Costa Rica was expedited by the air and encouragement of the Facultad de Biología, Universidad de Costa Rica, and the Organization for Tropical Studies. To all of the individuals and institutions we express our deep appreciation.

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## PHILANDER AND FOUR-EYED OPOSSUMS ONCE AGAIN

Philip Hershkovitz

*Abstract.*—Despite attempts by Pine (1973) and Husson (1978) to suppress *Philander* Tiedemann, 1808, as generic name for the four-eyed pouch opossum, *Didelphis opossum* Linnaeus (1758), it is shown that the type-species, *P. virginianus* Tiedemann, 1808, is a renaming or objective synonym of *Didelphis opossum* Linnaeus, with identical lectotype, the female four-eyed pouch opossum described and figured by Seba (1734).

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*Philander* Tiedemann, 1808, with type *Philander virginianus* Tiedemann, 1808 = *Didelphis opossum* Linnaeus, 1758, was established as the name for the four-eyed pouch opossum in 1949 when I reported its availability and designated the type-species. In 1973, Pine raised the question that the type-species, originally described as "rötlich braun . . ." could well be the pouchless four-eyed opossum known as *Metachirus nudicaudatus* E. Geoffroy 1803. In Pine's opinion, the pouched form was grayish, never brownish. Thereupon, he suggested suppression of the name *Philander* Tiedemann. However, grayish and brownish individuals occur among both pouched and non-pouched four-eyed opossums (Hershkovitz, 1976), and only pouched opossums were known to Tiedemann and all authors cited by him in his description of *Philander virginianus*.

Husson (1978:27) agreed with Pine regarding suppression of *Philander* Tiedemann but "for different reasons." None are given unless Husson refers to the anticipated effect of his use of a nomenclatural strategem.

In my discussions of the status of *Philander* Tiedemann, 1808, I (1949:11) noted that *P. virginianus* "is merely a new name for the four-eyed pouch opossum, *Didelphis opossum* Linnaeus," and (1949:12, 1976:302) designated the type-species of *Philander* Tiedemann as the equation "*Philander virginianus* Tiedemann = *Didelphis opossum* Linnaeus." Notwithstanding, Husson (1978:27) claims I "made the mistake to consider the name *Philander virginianus* Tiedemann, 1808, a replacement for *Didelphis opossum* Linnaeus 1758. It is true that Linnaeus's name is given as a synonym in Tiedemann's account, but there is no indication that it should be treated differently from the other references given under *Philander virginianus*. In fact *Philander virginianus* Tiedemann is a composite species based in part on *Didelphis opossum* Linnaeus . . . partly on *Metachirus nudicaudatus* (E. Geoffroy, 1803) . . . and partly on *Didelphis marsupialis* Linnaeus, 1758

. . . and the mention of Virginia as one of the type localities.” Husson then goes on to say that “so far as I know no lectotype has ever been designated for *Philander virginianus* Tiedemann, 1808, and therefore I now select as such the female specimen from Virginia discussed by Tyson (1698). In this way *Philander virginianus* Tiedemann, 1808, becomes a junior synonym of *Didelphis virginiana* Kerr (1792:103), and the generic name *Philander* Tiedemann, 1808, disappears in the synonymy of *Didelphis* Linnaeus, 1758.”

Husson errs in his judgment of a work he did not see (Husson, 1978:546). There is more than one indication that Tiedemann proposed the name *Philander virginianus* as a replacement for *Didelphis opossum* Linnaeus which, as senior objective synonym, becomes the correct name for the taxon. Tiedemann, it is noted (see Hershkovitz, 1949:11, for extract) introduced the two names in direct apposition thus: “P[hilander]. *virginianus* (Did. *opossum* L.).” The construction, as used here, is more than a mere indication. It is an equation consisting of two objective synonyms. This interpretation is supported by the fact that Tiedemann described no specimens before him or new species and he mentions no other scientific name. He simply *replaced* the old name *Didelphis opossum* Linnaeus for four-eyed pouch opossums by the new name combination *Philander virginianus*. The reference to Virginia was made in ignorance. Neither Tiedemann nor his contemporaries knew the distributional limits of the species they described.

The construction of paired binomials in direct apposition is employed by Tiedemann (1808:427–428) for the two remaining species of his genus *Philander*, but with only the new generic name used as replacement in the equated binomials, thus:

“2. Das mausartige Opossum *P. murinus* (Did. *murina* L.) . . . .

3. Das kurzgeschwäntze Opossum. *P. brachyurus* (Did. *brachyuros* Penn.) . . . .”

It is evident here and throughout his text that Tiedemann replaced older name combinations with new ones, whether his own or of other authors. Where alternate interpretations are possible, the decision of the first reviser holds.

A second indication is Tiedemann’s diagnosis of *Philander virginianus*, “Körper rötlich braun. Ueber jedem Auge ein gelblich/weisser Flecken. Schwanz so lang als der Leibe./ 1 Fuss und 3 Zoll lang ohne den Schwanz.” References to Buffon and Schreber’s figures leave no doubt that Tiedemann defined only the four-eyed pouch opossum. The description is followed by bibliographic references to works on opossum anatomy by Tyson (1698) and Cowper (1704).

Third, Tiedemann (1808:426, footnote *b*, [a reference not included in my 1949 extract]) based on the generic name *Philander* on the “*Philandri*” of the non-binomialist Brisson (1762:207). The diagnosis for the species Bris-



son names "Philander" derives from the same animals described by Seba (1734) under the name "Philander" and which served Linnaeus (1758:55) for the following description of *Didelphis opossum*:

3. D[idelphis]. cauda semipilosa, superciliarum regione pallidiore, mam-mis binis.

Philander, Opossum s. Carigueja. Seb. *mus.* 1. p. 56. t. 36. f. 1. 2.

*Habitat in America*

Abdomen circa mammas contrahitur in marsupium; polices postici mutici.

The repeated tautonymy in generic and specific names and the other indications pointed out above definitely equate *Philander virginianus* Tiedemann with *Didelphis opossum* Linnaeus. On the other hand, the genus *Philander* Tiedemann, 1808, is construed as a new taxon containing two of the five nominal species of the genus *Didelphis* Linnaeus, 1758, and "*P. brachyurus* (*Did. brachyuros* Penn.)" currently *Monodelphis brevicaudata* Erxleben, a species not included in the original Linnaean *Didelphis*.

Husson's motive for designating Tyson's animal as lectotype of *Philander virginianus* Tiedemann for the deliberate purpose of sinking the name *Philander* Tiedemann in the synonymy of *Didelphis* Linnaeus, is obscure. He could as readily have designated any of the four-eyed pouch opossums cited by Tiedemann. As it stands, Husson's action violates the letter and spirit of Recommendation 74A of the International Code of Zoological Nomenclature that "in designating a lectotype, a zoologist should in general act consistently with, and in any event should give great weight to, previous valid restrictions of the taxonomic species, in order to preserve stability of nomenclature." More to the point, Article 74(C) of the Code requires that "each designation of the lectotype must be made specifically for an individual nominal species [in this case *Philander virginianus*] and must have as its object the definition of that species." Tiedemann had already clearly defined his species as a four-eyed pouch opossum. Tyson's opossum is not that species and cannot serve for its definition. Such specimens not seen but cited by the author in or appended to the description of a species, are properly treated as misidentified referrals and not in the sense of syntypes. In any event, my (1976:297) prior designation of the female four-eyed pouch opossum described and figured by Seba (1734:56, pl. 36, fig. 2) as the lectotype of *Didelphis opossum* Linnaeus, 1758, makes it *ipso facto* the lectotype of the junior objective synonym *Philander virginianus* Tiedemann, 1808. *Metachirops* Matschie, 1916, also with type *Didelphis opossum* Linnaeus, is an objective junior synonym of *Philander* Tiedemann, 1808.

In conclusion, I find no zoological support for Pine's (1973) opinion that *Philander virginianus* Tiedemann is conspecific with *Metachirus nudicaudatus* E. Geoffroy, and no zoological or nomenclatural justification for Husson's (1978) attempt to convert the name *Philander virginianus* Tiedemann,



already restricted to four-eyed pouch opossums, into a synonym of *Didelphis virginianus* Kerr, for the Virginia opossum.

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*POLYDORA* AND *BOCCARDIA* SPECIES (POLYCHAETA:  
SPIONIDAE) FROM WESTERN MEXICO,  
CHIEFLY FROM CALCAREOUS HABITATS

James A. Blake

*Abstract.*—Nine species of spionid polychaetes are reported from the Gulf of California. Most species are borers in various gastropod shells. The description of *Polydora nuchalis* is clarified and *P. heterochaeta* is redescribed. *Polydora barbilla* is new to science. *Polydora anophthalma* is transferred to *Boccardia* and redescribed.

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A list of polychaetes from the Gulf of California was provided by Reish (1968), who recorded 20 species of Spionidae. Additional species were added by Light (1970), Fauchald (1972), Kudenov (1973, 1975) and Blake (1979a) bringing the total number to about 30. In general, the shell boring spionids from the Gulf of California have not been studied. Recently, while conducting revisionary work on the Spionidae, it was possible to examine several gastropod shells from various localities in the Gulf of California. Spionids were recovered following dissolution of the shells in an acidified alcohol solution (70% isopropanol + HCl). These forms are reported herein along with some additional records from benthic habitats.

The collections are deposited in the Allan Hancock Foundation, University of Southern California (AHF), National Museum of Natural History, Smithsonian Institution (USNM) and the California Academy of Sciences (CAS).

The following spionid species from Mexico are included in this report: *Polydora barbilla*, new species; *Polydora convexa* Blake and Woodwick, 1972; *Polydora socialis* (Schmarda, 1861); *Polydora giardi* Mesnil, 1896; *Polydora nuchalis* Woodwick, 1953; *Polydora websteri* Hartman, 1943; *Polydora heterochaeta* Rioja, 1939; *Boccardia anophthalma* (Rioja, 1962), new combination; *Boccardia tricuspa* (Hartman, 1939).

*Polydora barbilla*, new species

Fig. 1

*Material examined.*—MEXICO, Gulf of California, 3-5 km west of Puerto Peñasco, 15 m, from shell of *Muricanthus nigratus*, 20 March, 1971, coll. J. D. Kudenov, holotype (AHF Poly 1296), 10 paratypes (AHF Poly 1297) and 5 paratypes (USNM 58978).

*Description.*—A moderate sized species, up to 12 mm long and 0.5 mm

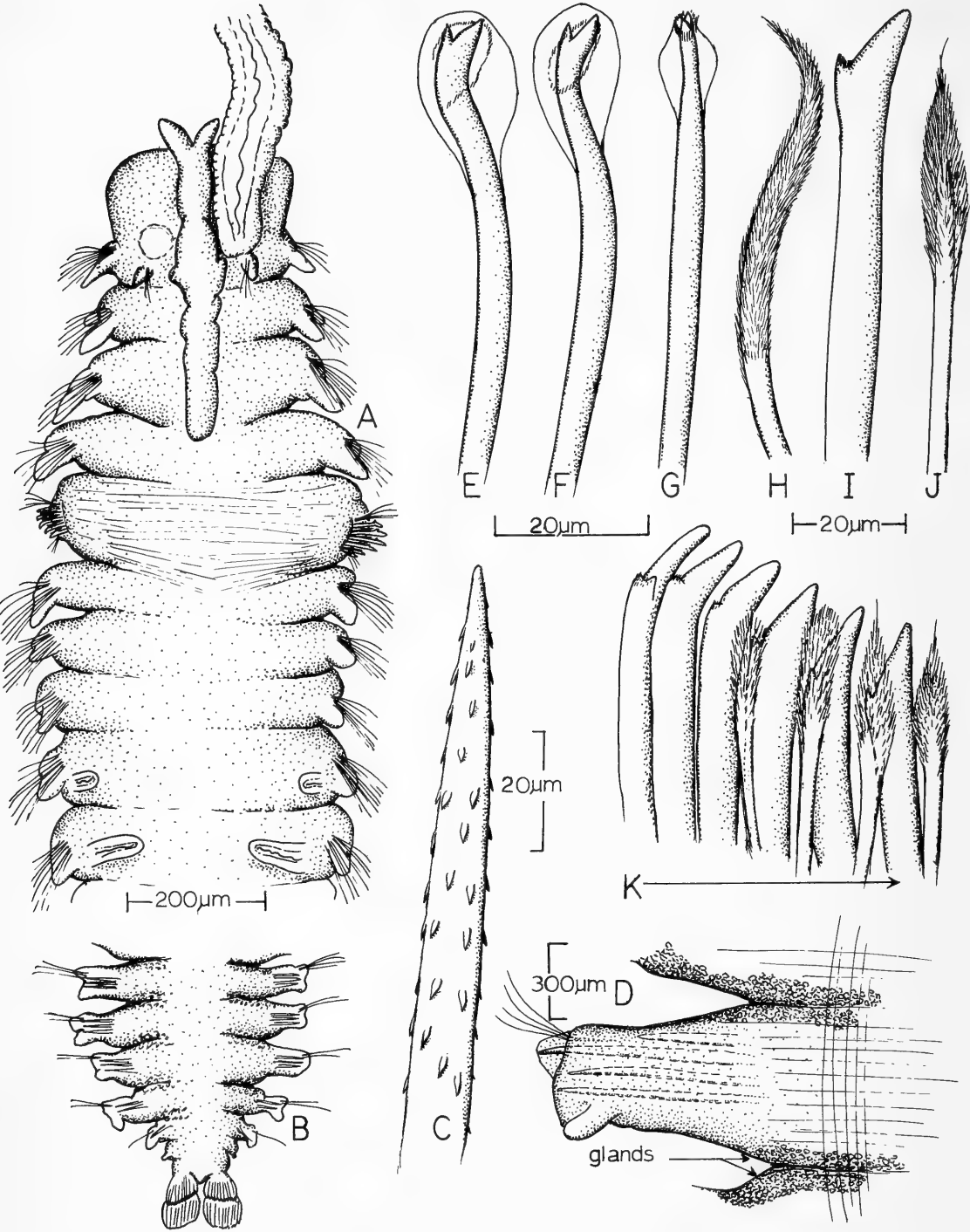


Fig. 1. *Polydora barbilla* (paratype, AHF Poly 1297): A, Anterior end in dorsal view; B, Posterior end in dorsal view; C, Notopodial acicular spine from posterior setiger showing basally directed barbs; D, Posterior parapodium in dorsal view showing location of acicular spines; E-G, Hooded hooks; H, Dorsal geniculate seta from setiger 5; I, Major spine from setiger 5; J, Companion seta from setiger 5; K, Fascicle of major spines and companion setae from setiger 5.

wide for about 130 segments. Color: light tan in alcohol, some specimens with dorsal intersegmental pigment bands. Intersegmental glands present in middle and posterior setigers (Fig. 1D).

Prostomium deeply incised on anterior margin (Fig. 1A), with caruncle extending to posterior margin of setiger 3; no occipital tentacle; eyes 0–4. Peristomium enlarged, truncate on anterior margin; palps long, thin, reaching posteriorly for about 20 segments.

Setiger 1 with long, fingerlike notopodial lobes; notosetae short, with two tiers of thin capillaries; setigers 2–4, 6 and subsequent setigers with notosetal fascicles of bilimbate capillaries arranged in two tiers, setae of anterior tier being shorter than posterior tier; posterior setigers with 3–4 emergent or imbedded acicular spines and 3–5 long capillaries (Fig. 1B–D), each spine with minute barbs basally directed on shaft (Fig. 1C). Neurosetae of setigers 1–4 and 6 with capillaries arranged in two tiers as described for notosetae; bidentate hooded hooks from setiger 7, numbering 4–6 throughout most of body, then diminishing to 2 in far posterior segments; hooks accompanied by capillaries for only 5 or 6 segments; hooks lacking constriction or manubrium on shaft, with angle between teeth being less than  $90^\circ$  but about  $150^\circ$  between main fang and shaft (Fig. 1E–F); apical tooth difficult to see in some angles (Fig. 1G), but always present; hood opening with fine bristles (Fig. 1E–G).

Setiger 5 modified, larger than either 4 or 6 (Fig. 1A); setae including superior dorsal fascicle of 5 or 6 finely bristled geniculate setae (Fig. 1H), curved row of major spines (Fig. 1I, K) with bilimbate companion setae (Fig. 1J–K) and ventral fascicle of bilimbate capillaries; major spines falcate with finely bristled collar on convex side.

Branchiae from setiger 9–10, small at first, reaching full-size by setigers 12–14, absent from posterior one-half of body.

Pygidium with 4 lobes, dorsal pair being distinctly smaller than ventral pair (Fig. 1B).

*Etymology*.—*barbilla*: Spanish for barb, as on a fish.

*Remarks*.—*Polydora barbilla* is closely related to *P. langerhansi* Mesnil, 1896, from Madeira, *P. convexa* Blake and Woodwick, 1972, from California and *P. pilocollaris* Blake and Kudenov, 1978, from Victoria, Australia in having a flange or collar on the convex side of the major spines of setiger 5. Only *P. barbilla* and *P. convexa*, however, have spines in posterior notopodia. In *P. barbilla*, these spines are of a unique acicular type bearing minute, basally directed barbs. *P. convexa*, on the other hand, has small posterior needles arranged in flattened packets. *P. barbilla* has branchiae from setiger 9–10 and bidentate hooded hooks occurring throughout, while *P. convexa* has branchiae from setiger 8 and unidentate hooded hooks in posterior neuropodia.

Rioja (1939) described a larval stage (*Polydora* sp.) from Acapulco having

similarly appearing major spines on setiger 5 as occur in *P. barbilla* and *P. convexa*. Since both species are now known to occur in the Gulf of California, it is not possible at this time to assign Rioja's record to either species until their larval morphologies are described.

*Distribution*.—Mexico: Gulf of California, boring into gastropod shells.

*Polydora convexa* Blake and Woodward, 1972

*Polydora convexa* Blake and Woodward, 1972:73–74, fig. 1.

*Material examined*.—MEXICO, Gulf of California, 3–5 km west of Puerto Peñasco, 15 m, from shell of *Muricanthus nigritus*, 20 March 1971, coll. J. D. Kudenov, 1 specimen (AHF).

*Remarks*.—The Mexican specimen agrees with the description of specimens from California by Blake and Woodward (1972), except that the nature of the posterior spines was originally misconstrued. They were said to be tight fibril bundles, but are instead flattened packets of needles, similar to those reported for *Polydora flava* and *P. latispinosa* by Blake and Kudenov (1978). These structures glisten and shine in the posterior segments of the animal and make it possible to separate the species from others in a sample.

*Distribution*.—Mexico and California. A borer of mollusk shells; also reported from algal holdfasts, sponges, *Dodecaceria* colonies, and bryozoa by Blake and Woodward (1972).

*Polydora socialis* (Schmarda, 1861)

*Polydora socialis*.—Blake, 1971:20–23, fig. 13 [Synonymy]; 1979b:607–609.—Light, 1978:179–181, fig. 180a–l [Synonymy].—Rioja, 1947:207–208.

*Polydora socialis plena*.—Reish, 1968:82.

*Material examined*.—MEXICO, Bahía de Los Angeles, April 1962 and October 1963, coll. Beaudette Foundation, Sta. 3, 2 specimens (USNM 58983); Sta. 5, 1 specimen (USNM 58984); Sta. 9, 1 specimen (USNM 58985); Sta. 28, 1 specimen (USNM 58986); Sta. 36, 2 specimens (USNM 58987); Sta. 146, 1 specimen (USNM 58988). San Felipe, near mouth of Arroyo Estralla, boring in shell of *Muricanthus nigritus* occupied by hermit crab, 12 April 1952, coll. L. O. Miles, 10+ specimens (AHF).

*Remarks*.—*Polydora socialis* is widespread and may prove to be cosmopolitan once sufficient material is examined. The species appears to be highly opportunistic and occupies benthic habitats as well as the shells of mollusks. The present specimens agree well with published descriptions.

*Distribution*.—East, west, and gulf coasts of North America; Chile; Australia.

*Polydora giardi* Mesnil, 1896  
Fig. 2A–B

*Polydora giardi* Mesnil, 1896:195–202, pl. 13, figs. 1–12.—Fauvel, 1927:50–52, fig. 17h–m.—Hartman, 1941:309, pl. 48, fig. 43; 1961:29; 1969:135–136, figs. 1–6.—Rioja, 1941:727; 1943:230.—Rainer, 1973:560, fig. 9.—Read, 1975:413.—Blake and Kudenov, 1978:252, fig. 38i–k.

*Material examined*.—MEXICO, Sonora, off Cholla, 16.7 m, boring into shell of gastropod, 26 Dec. 1966, coll. T. A. Burch, 3 specimens (CAS 010131).

*Remarks*.—*Polydora giardi* is a small species, seldom exceeding 6–7 mm in length, and characterized by having an incised prostomium, a tooth on the major spines of setiger 5, branchiae usually from setiger 9, and by lacking a constriction on the hooded hooks and posterior notopodial spines. Its closest relative appears to be *P. tridenticulata* Woodwick from the central Pacific, which differs only in having 2 distinct teeth on the major spines of setiger 5. Two undescribed species from the eastern Pacific have been discovered which appear to be closely related to *P. giardi* and *P. tridenticulata*. Both forms, however, have posterior notopodial spines.

The setal morphology of *P. giardi* and *P. tridenticulata* poses some interesting questions with regard to the consistency of having 1 or 2 accessory teeth on the major spines of setiger 5. Some specimens of *P. giardi* from the eastern Pacific appear to have a second spur on the opposite side from the large accessory tooth. The large accessory tooth is clearly seen with the scanning electron microscope (SEM) (Fig. 2A). The same figure also reveals a thin, closely adhering protuberance on the opposite side. This structure is difficult to detect, but appears to flare at its apex into several bristles. It is not known how common this structure is among *P. giardi* populations, or whether it is homologous to the large second accessory tooth of the related species, *P. tridenticulata*. Rice and Simon (1980) have observed that a small percentage of some Florida populations of *P. ligni* have an extra accessory tooth on the major spines of setiger 5. This suggests to me that such structures among species of *Polydora* may represent small scale genetic variation rather than wide scale species level morphological criteria. Whether or not such a system is operative in *P. giardi* and its relatives remains to be determined.

Figure 2A also reveals that the companion setae of setiger 5 are distinctly bristled. The hooded hooks are also bristled on their apical ends, with the teeth only barely protruding through the hood opening (Fig. 2B).

*Polydora nuchalis* Woodwick, 1953  
Figs. 2C–D, 3

*Polydora nuchalis* Woodwick, 1953:381–383, fig. 1a–f; 1960:122–128, pls.

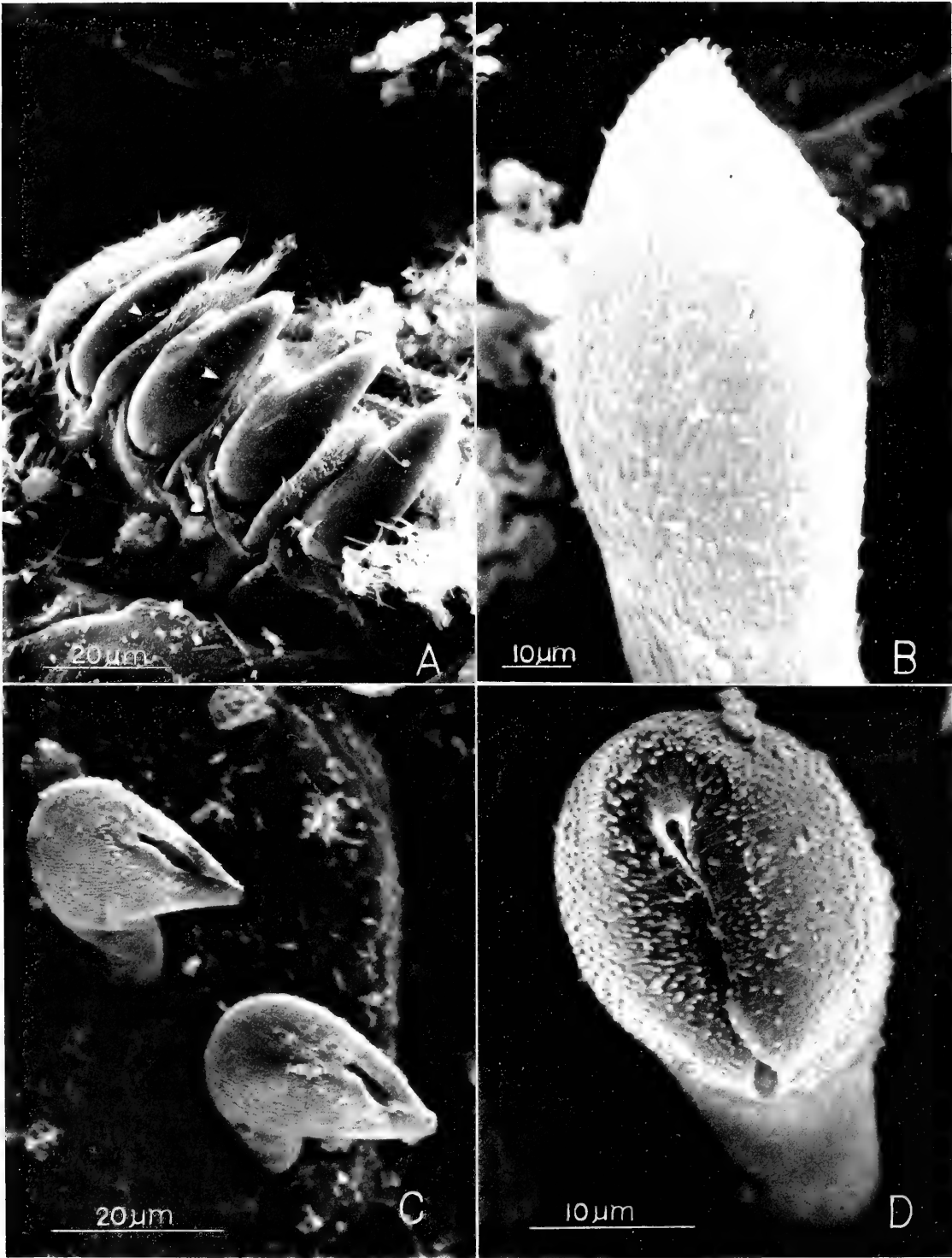


Fig. 2. *Polydora giardi*: A, Fascicle of major spines from setiger 5, arrows denotes locations of small adhering secondary spurs; B, Hooded hook.—*Polydora nuchalis*: C, Two hooded hooks in apical view; D, Hooded hook in dorsofrontal view. SEM micrographs.

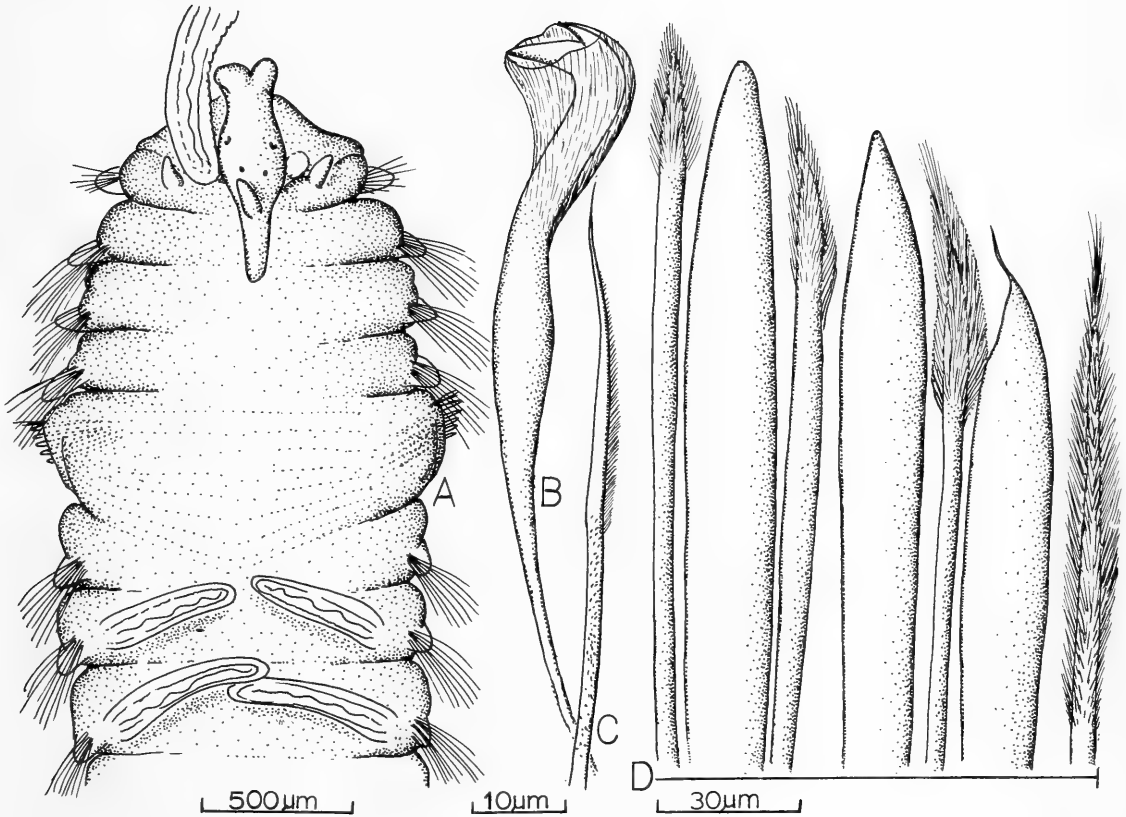


Fig. 3. *Polydora nuchalis*: A, Anterior end of Mexican specimen in dorsal view; B, Hooded hook; C, Fimbriated capillary notoseta from setiger 5; D, Group of companion setae and major spines from setiger 5.

1–3.—Hartman, 1961:29; 1969:143–144, figs. 1–5.—Blake, 1975:215.—Light, 1978:177.—Kudenov, 1973:116–117; 1975:206.

**Material examined.**—MEXICO, Puerto Peñasco, Bahía Cholla, high intertidal sand flats, occurring in dense mats, 19 Jan. 1972, coll. J. D. Kudenov, 2 specimens (AHF). CALIFORNIA, Duxbury Reef, near Bolinas, from high intertidal rock platform, in sand on bottom of pool, 2 Feb. 1978, coll. J. A. Blake (CAS 010130).

**Description.**—Specimens from Cholla Bay up to 19 mm long and 1 mm wide for approximately 110 segments. Color: light tan in alcohol, no pigment.

Prostomium incised on anterior margin, continuing posteriorly as caruncle to setiger 3 (Fig. 3A); two pairs of eyes: anterior pair cup-shaped, posterior pair oval-shaped and less widely spaced; occipital tentacle present posterior to eyes.

Setiger 1 with dorsally elevated, short notopodial lobes, notosetae absent; capillary notosetae of setigers 2–4, 6 and subsequent setigers unilimbate,



arranged in 2 tiers, with anterior tier bearing shorter setae; posterior setigers with 4–5 long capillaries, posterior spines lacking. Capillary neurosetae of setigers 1–4 and 6 similar to corresponding notosetae, those of setiger 1 thinner; bidentate hooded hooks replace capillaries from setiger 7; hooks with constriction and manubrium on shaft, hood with fine striations (Fig. 3B) evident in light microscopy, but seen to be minute bristles with SEM (Fig. 2C–D).

Setiger 5 modified, with setae including superior dorsal fascicle of fimbriated capillaries bearing punctations on shaft (Fig. 3C), curved row of simple major spines alternating with bristled companion setae bearing numerous fine bristles (Fig. 3D), and ventral fascicle of unilimbate capillaries.

Branchiae from setiger 7, continuing to near posterior end; gills long, meeting at midline. Pygidium disclike, with wide dorsal gap.

*Remarks.*—There is confusion in the literature concerning the true nature of the companion setae of setiger 5 for *P. nuchalis*. Woodwick (1953, fig. 1e) termed these setae plumose and figured them as having the end of the shaft covered with numerous bristles. Light (1978:177), on the other hand, indicated that these setae are geniculate with a distinct limbus. He also mentioned that the hooded hooks lacked a manubrium, although Woodwick's fig. 1f suggests that a constriction is present on the shaft. In the present study, *P. nuchalis* has been observed to have companion setae on setiger 5 which are very similar to those depicted by Woodwick. The ends of the shaft are covered with numerous fine bristles, observed both with the light microscope and SEM. At low magnifications (400 $\times$ ) with light microscopy, the setae appear to be bilimbate, with the bristles visible under oil immersion (1,000 $\times$ ). The hooded hooks have a manubrium and constriction on their shafts. The bristles observed on the hoods have not been described previously, but have been observed on most other spionids when examined under SEM.

*Distribution.*—Mexico: Gulf of California; California.

*Polydora websteri* Hartman, 1943

*Polydora websteri.*—Blake, 1971:6–8, fig. 3 [Synonymy].—Foster, 1971:26–27, figs. 30–36 [Synonymy].

?*Polydora ciliata.*—Rioja, 1943:229 [not Johnston, 1838].

*Material examined.*—MEXICO, Gulf of California, 3–5 km west of Puerto Peñasco, 15 m, from shell of *Muricanthus nigratus*, 20 March 1971, coll. J. D. Kudenov, 15 specimens (AHF); Sonora, off Cholla, 16.7 m, with bryozoa and shell fragments, 26 Dec. 1966, coll. T. A. Burch, 1 specimen (CAS 000114).

*Remarks.*—These specimens agree well with the published descriptions. It is probable that the record of *P. ciliata* by Rioja (1943) from Guymas may

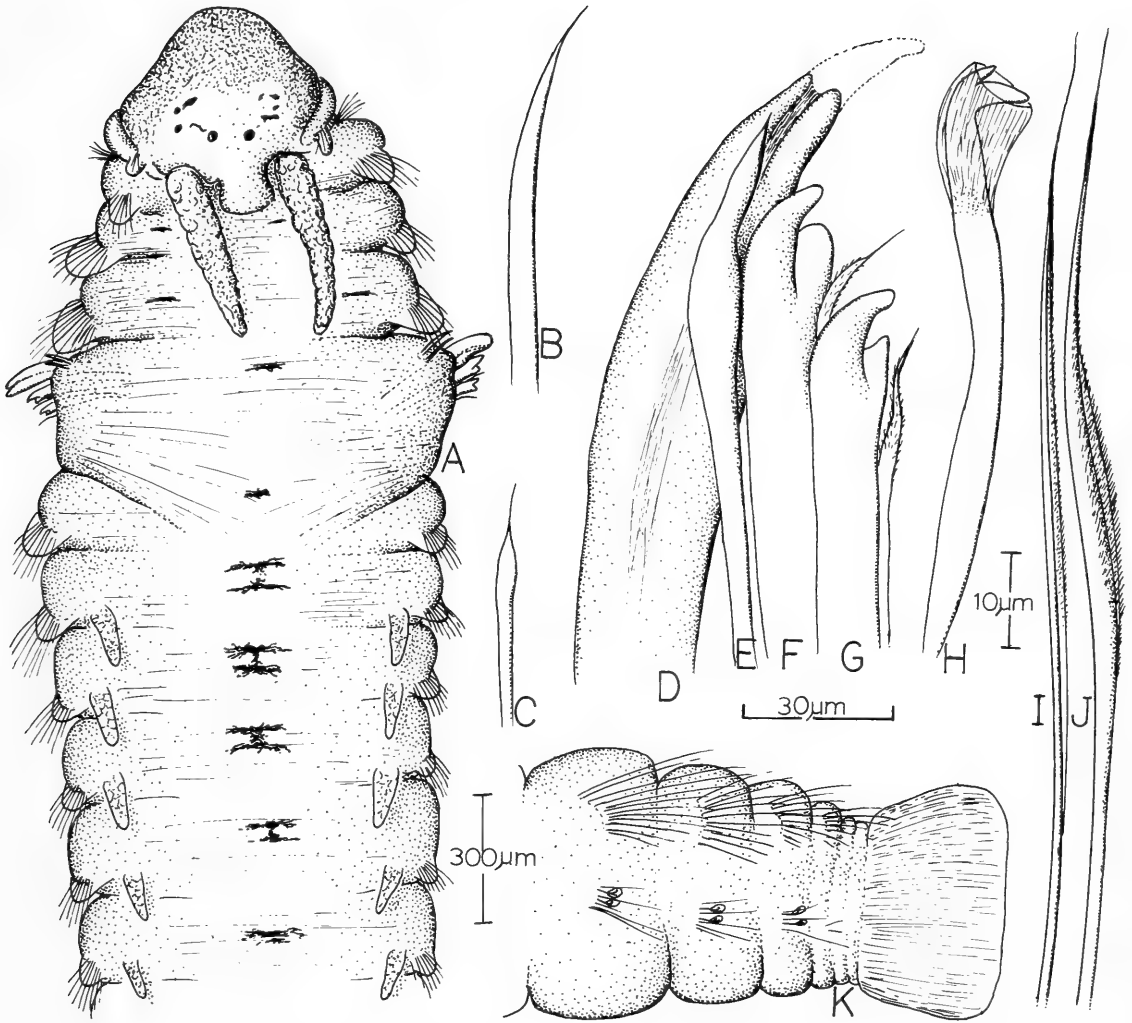


Fig. 4. *Polydora heterochaeta*: A, Anterior end in dorsal view; B, Dorsal capillary notoseta from setiger 5; C, Ventral capillary neuroseta from setiger 5; D, Giant falcate spine from setiger 5; E, Inflated spine from setiger 5; F–G, Normal major spines and hastate companion setae from setiger 5; H, Hooded hook; I, Capillary notoseta from anterior tier of anterior setiger; J, Capillary notoseta from posterior tier of same; K, Posterior end with pygidium in lateral view.

be *P. websteri*, but since Rioja's specimens are no longer available, new materials will need to be collected.

*Distribution*.—East, west, and gulf coasts of North America; Australia.

*Polydora heterochaeta* Rioja, 1939

Fig. 4

*Polydora heterochaeta* Rioja, 1939:308–309, figs. 6–10; 1962:185.—Reish, 1968:82.

*Material examined.*—MEXICO, Bahía de Los Angeles, in silty sands, Oct. 1963, coll. Beaudette Foundation, Sta. 2, 1 specimen (USNM 58981); Sta. 102, 1 specimen (USNM 58982).

*Description of postlarval juvenile.*—Both specimens small, 2.3 and 2.5 mm long for 28 and 26 setigers, respectively, both 0.5 mm wide. Color in alcohol: brown with paired pigment bars on dorsum of setigers 3 and 4, medial chromatophores on dorsum of setigers 5–11, with chromatophores of setigers 7–11 arranged as 2 tandem spots (Fig. 4A). Parapodia, branchiae and much of body with conspicuous glandular appearance.

Prostomium broad, entire on anterior margin; caruncle extending posteriorly to end of setiger 2; eyes numerous with pair of large oval ones located medially and about 4 pairs of small ones more laterally and anteriorly located (Fig. 4A). Peristomium reduced, fused to setiger 1; palps short, thin, posteriorly directed to setiger 5.

Setiger 1 reduced, with small noto- and neuropodial lobes; with 4–5 long notosetae on one specimen, lacking on second specimen; neurosetae delicate capillaries. Setigers 2–4, 6 and subsequent setigers with 2-tiered fascicles of unilimbate, fimbriated capillary notosetae, those of posterior tier being longer (Fig. 4I, J); capillaries of posterior setigers also fimbriated, but longer and more robust than those of anterior setigers imparting spinous appearance to posterior end (Fig. 4K). Neurosetae of setigers 2–4 and 6–8 include fimbriated capillaries, arranged in 2 tiers; bidentate hooded hooks replace anterior tier from setiger 9, posterior tier of capillaries remaining intact throughout body; hooks numbering 2–4 throughout, with striations on hood and weak constriction on shaft (Fig. 4H).

Setiger 5 enlarged and greatly modified; setae include 2 simple dorsal capillaries (Fig. 4B), 3 types of major spines with slender hastate companion setae (Fig. 4D–G) and a ventral fascicle of 2–3 inflated capillary neurosetae (Fig. 4C); major spines include a single giant falcate spine with long lateral groove (Fig. 4D) [tip end of this spine usually broken off, imparting bilobed appearance to end of shaft], a single pointed spine with subterminal inflated portion (Fig. 4E) and 2–3 falcate spines bearing a large accessory tooth (Fig. 4F, G), these accompanied by hastate companion setae.

Branchiae from setiger 7; gills slender, glandular, continuing for 10 segments. Pygidium cufflike, with distinct striations (Fig. 4K).

*Remarks.*—The fully developed adult form of *Polydora heterochaeta* has never been discovered and the present postlarval specimens from Bahía de Los Angeles differ somewhat from the original description of planktonic larvae by Rioja (1939) from Acapulco. In Rioja's form, the hooded hooks were said to begin on setiger 7 instead of 9 and the dorsal chromatophores were depicted as paired throughout the body, while the present specimens have paired chromatophores only on setigers 3 and 4, with medial chromatophores on subsequent segments. The major spines of setiger 5 are gen-

erally of the same form as Rioja described, although he did not observe the inflated spine.

Blake (1969) commented on the validity of *P. heterochaeta* and other species which have been based upon larval or postlarval forms. *Polydora heterochaeta* exhibits several features which are typical of such postlarval forms. These include the poorly developed peristomium, undifferentiated and broadened prostomium, posteriorly directed palps, retention of larval pigment and the occurrence of multiple major spine types on setiger 5. Extra spine types, similar to those described here for *P. heterochaeta*, have been described for the larvae or postlarvae of *P. ciliata* (Johnston) and *P. hoplura* Claparède by Wilson (1928), *P. hermaphroditica* Hannerz (1956), *P. biocipitalis* Blake and Woodwick (1972) and *P. websteri* Hartman by Blake (1969). These setae are represented in *P. heterochaeta* by the giant falcate spine (Fig. 4D) and the inflated spine (Fig. 4E). In other species, these setae are the first modified spines to appear on setiger 5 during development and the first to drop off, being entirely replaced by the typical form found on adults. In *P. heterochaeta* the adult form of major spine is that represented in Fig. 4F, G. These spines have an enlarged sheathlike accessory tooth, which should make it possible to identify the adults of this species when other characters, such as the hooded hooks beginning on setiger 9, are considered.

*Distribution*.—Mexico: Acapulco and the Gulf of California.

*Boccardia anophthalma* (Rioja, 1962), new combination  
Fig. 5

*Polydora anophthalma* Rioja, 1962:185–188, figs. 89–93.

*Material examined*.—MEXICO, Gulf of California, 3–5 km west of Puerto Peñasco, 15 m, from shell of *Muricanthus nigritus*, 20 March 1971, coll. J. D. Kudenov, 4 specimens (AHF).

*Description*.—A moderate-sized species, up to 14 mm long and 1.0 mm wide for 85 segments. Color in alcohol: light tan, pigment lacking.

Prostomium and first 5 setigers dorsoventrally compressed; subsequent body segments normal-appearing, oval to rounded in cross-section. Prostomium truncate on anterior margin (Fig. 5A); caruncle narrow, twisted, continuing posteriorly to end of setiger 4; no eyes; no occipital tentacle. Palps thin, short, extending posteriorly for 11 or 12 segments.

Setiger 1 reduced, with notopodial lobe, lacking notosetae; with short, thin capillary neurosetae. Setigers 2–4, 6 and subsequent segments with unilimbate capillary notosetae arranged in 2 tiers, first tier with short thickened setae, those of second tier longer and thinner; notosetae of posterior segments reduced to 5 or 6 simple capillaries; last 10 to 12 segments with elevated parapodia bearing 2–4 long capillaries and 1–2 stout recurved

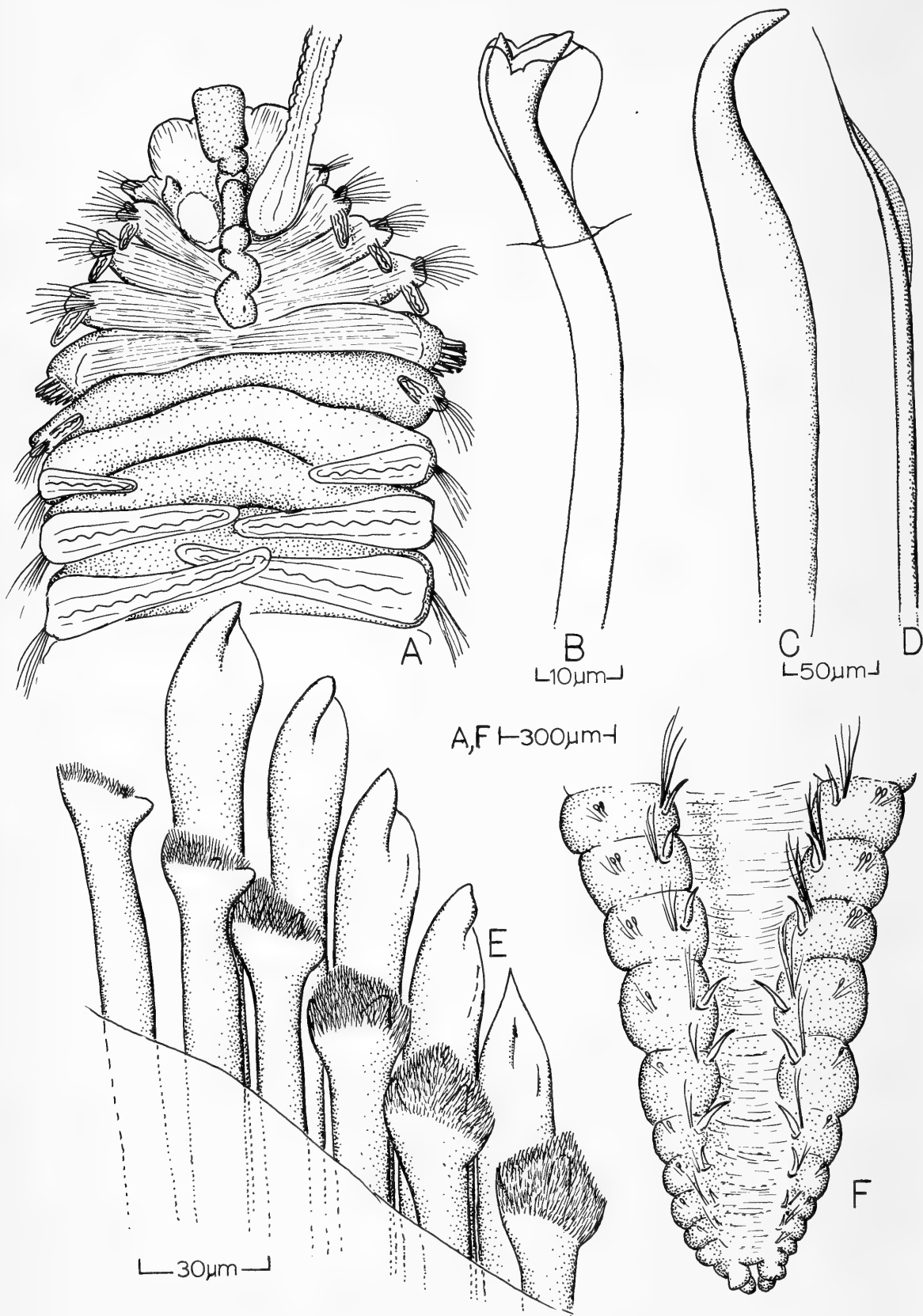


Fig. 5. *Boccardia anophthalma*: A, Anterior end in dorsal view; B, Hooded hook; C, Notopodial boathook from posterior setiger; D, Unilimbate capillary neuroseta from setiger 5; E, Group of major spines from setiger 5; F, Posterior end in dorsal view.

boathooks (Fig. 5C, F) projecting into shallow medial channel. Neuropodia of setigers 2–4, 6 with fascicles of unilimbate capillaries; bidentate hooded hooks from setiger 7 numbering 6–8 throughout most of body, then reduced to 2–3 in far posterior segments; accompanied by 1–3 inferior capillaries; hooks exhibiting wide angle between teeth (Fig. 5B).

Setiger 5 with ventral fascicle of 5–6 unilimbate capillaries (Fig. 5D); major spines of 2 types: (1) falcate with flange along curved edge (Fig. 5E); (2) bristle-topped with small tooth among bristles (Fig. 5E).

Branchiae on setigers 2–4, 6 and subsequent segments (Fig. 5A), continuing for most of body length, absent from those posterior segments having boathooks; gills short on setigers 2, 3, 4, and 6, reaching full-size on setiger 8, overlapping at midline, then becoming short again in posterior one-half of body.

Pygidium reduced to 4 minute lobes surrounding anal opening (Fig. 5F).

*Remarks.*—*Polydora anophthalma* Rioja (1962) was described and figured as having branchiae from setiger 8, but the posterior end was not described. In most respects, however, the present specimens agree well with Rioja's description. The major spines of setiger 5 are unique. There is no other example of a *Boccardia* species having an accessory structure on the falcate unbristled spines. The flange occurring on these spines in *B. anophthalma* was illustrated by Rioja for his specimens. Since the anterior branchiae are considerably smaller than those following setiger, it seems probable that Rioja overlooked them, as did Hartman (1939:16) for *B. tricuspa* (see Woodwick, 1963:209). I strongly feel that the evidence indicates that the present specimens represent the form which Rioja described as *Polydora anophthalma*.

With the addition of *B. anophthalma*, *Boccardia*, as emended by Blake and Kudenov (1978) now has 17 species. *Boccardia anophthalma* is most closely related to *B. berkeleyorum* Blake and Woodward (1971) in having a small tooth on the bristle-topped spines of setiger 5, posterior notopodial spines and 4 small pygidial lobes. In *B. anophthalma*, however, the falcate spines of setiger 5 have an accessory flange and the posterior spines are recurved. *B. berkeleyorum*, on the other hand, has simple falcate spines on setiger 5 and posterior acicular spines. The unusual flattened appearance of the anterior end of *B. anophthalma* is caused by dorsal-ventral compression of the prostomium and first 5 setigers. The functional significance of this flattening is not understood, but it may be related to its shell-boring habit.

*Distribution.*—Mexico, Gulf of California; Asuncion Island, a borer into mollusk shells.

*Boccardia tricuspa* (Hartman, 1939)

*Polydora tricuspa* Hartman, 1939:16–17, fig. 3c–k; 1961:29.—Rioja, 1939:304–308, figs. 22–31; 1941:727; 1943:238; 1962:185.

*Boccardia tricuspa*.—Woodwick, 1963:209–212, fig. 1.—Hartman, 1969:99–100, figs. 1–5.

*Boccardia proboscidea*.—Carrasco, 1974:185–187, figs. 1–4 [not Hartman, 1940], *fide* Blake and Kudenov, 1978:238.

*Material examined*.—MEXICO, Gulf of California, 3–5 km west of Puerto Peñasco, 15 m, from shell of *Muricanthus nigratus*, 20 March 1971, coll. J. D. Kudenov, 1 specimen (AHF). Guadalupe Island, Melbomene Cove, intertidal in shell of *Haliotis* sp., Velero Sta. 1912–49, 17 Dec. 1949, 5 specimens (AHF). Guadalupe Island, Camp Arroyo, Lava Point, intertidal, 10 July 1975, coll. D. Sutton, 1 specimen (CAS 009331), 3 specimens (CAS 009371).

*Remarks*.—The major spines of setiger 5 of *B. tricuspa* have a more complex structure than previously believed. The spines are of 2 types: (1) a simple falcate spine, (2) a cusped spine generally noted by previous investigators to have 3 teeth. The end of the cusped spine is produced laterally to form a tooth at either end. Between these teeth is a narrow ridge which bears a thin curtain. This structure is what is generally considered to be a medial or third cusp. Being very thin and fragile, it is easily worn into different forms and configurations, but is usually gone from the oldest and most worn spines in a setal fascicle series. On the inner edge of the ridge between the lateral teeth are numerous fine bristles. These, too, are best seen on the youngest spines, being mostly worn away on the older ones. The presence of bristles on these teeth allies *B. tricuspa* more closely to other species of the genus which have the ends of their spines entirely covered with bristles. Detailed comparative studies of these spines of the various species is in progress, using the SEM, and it is expected that these studies will help clarify such relationships.

*Distribution*.—California, Mexico, Galapagos Islands, Chile.

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A NEW FISH SPECIES OF THE GENUS  
*VANDERHORSTIA* (TELEOSTEI: GOBIIDAE)  
FROM THE AMIRANTE ISLANDS,  
INDIAN OCEAN

Ernest A. Lachner and James F. McKinney

*Abstract.*—*Vanderhorstia praealta*, a new species of the fish family Gobiidae, is described from the Amirante Islands, Indian Ocean. *Vanderhorstia praealta* resembles the *Cryptocentrus*-like gobies, a large group of more than 60 species comprising at least seven genera. We provisionally place *V. praealta* in the genus *Vanderhorstia* because it lacks vertical rows of cutaneous papillae on the cheek, has a moderate number of scales in the lateral series (54), a moderate gill opening, and an elongate caudal fin. *Vanderhorstia praealta* has an extremely elongate first dorsal fin; spines I-III are longest, about equal in length and 62.5% of the standard length. The species is known by only one specimen.

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The new species was captured by the field crew of the Seychelles Islands Program, 1964, of the U.S. National Science Foundation International Indian Ocean Expedition organized by James E. Böhlke, Academy of Natural Sciences, Philadelphia. We provisionally place this species in the genus *Vanderhorstia* Smith (1949:103). Superficially our new species resembles the *Cryptocentrus*-like gobies, a large group of more than 60 species of which the following genera are probably interrelated: *Cryptocentrus* Valenciennes, *Amblyeleotris* Bleeker, *Mars* Jordan and Seale, *Vanderhorstia* Smith, *Flabelligobius* Smith, *Ctenogobiops* Smith, and *Eilatia* Klauswitz. A single character is often used to distinguish among these genera. The most frequently used generic (or group) characters are: number of vertical and horizontal rows of cutaneous papillae on the cheek; length of caudal fin; extent of gill opening; size and number of rows of teeth in the jaws; kind and number of scales on the trunk; presence of tubular nares; shape of head (depressed, compressed); length of snout; and width and contour of gape. One can demonstrate with ease that a particular gobiid species is new, but to allocate it properly to a genus is difficult. This problem has resulted in the description of many new genera without any meaningful, comparative analysis of generic characters and their generic group affinities. Our new species lacks vertical rows of papillae on the cheek and therefore does not agree with the generic concept that Hoese and Steene (1978:382) presented for *Cryptocentrus* and *Amblyeleotris*, each having variously developed vertical

or transverse rows of papillae on the cheek. On the basis of the development of papillae on the cheek, the genus *Mars* (including *Obtortiophagus* Whitley as a synonym) should be linked with the *Cryptocentrus*-*Amblyeleotris* group. The four other nominal genera—*Vanderhorstia*, *Flabelligobius*, *Ctenogobiops* and *Eilatia*—have no vertical rows of papillae on the cheek. *Flabelligobius* has a long jaw, a pointed snout, minute scales numbering over 100 in the lateral series, and a narrow gill opening restricted to the pectoral fin base (Smith, 1959:205, fig. 22). *Ctenogobiops* has ctenoid scales, and the gill opening is extensive (Smith, 1959:191). *Eilatia* has cycloid and ctenoid scales, and a restricted gill opening; the caudal fin is longer than the head length, and the head is depressed (Klausewitz, 1974:206). *Vanderhorstia* has about 50–65 scales in the lateral series, and cycloid and ctenoid scales; the gill opening is wide (Smith, 1959:192). Our new species has no vertical rows of papillae on the cheek, has 54 scales in the lateral series, all cycloid scales, a moderate gill opening, head moderately round, caudal fin longer than length of head, teeth of jaws caninoid, in 2 to 4 rows, and the anterior nares opening on a short tube. The first dorsal fin spines I–IV are very long and spines I–III are nearly equal in length. The combination of these characters does not agree with the characters listed for any of the above seven genera. Some characters, such as the width of the gill opening, may be less variable among the genera and species than the number of scales on the trunk or the length of the caudal fin. However, all of the characters mentioned above must receive a comparative evaluation among all of the related nominal genera and included species in order for us to ascertain practical or natural generic groupings. We place our new species in *Vanderhorstia* because of the moderate number of scales in the lateral series, the moderate gill opening and the elongate caudal fin. Also, the genus *Vanderhorstia* has priority among the nominal *Cryptocentrus*-like gobies that lack vertical rows of cheek papillae.

The methods of taking and recording counts and data are given in Lachner and McKinney (1974, 1978).

Important comparative material studied for generic determination includes: *Amblyeleotris guttata*, USNM 220084, Philippines; *Amblyeleotris randalli*, USNM 220085, Philippines; *Cryptocentrus cryptocentrus*, USNM 220078, St. Brandon Shoals, Indian Ocean; *Ctenogobiops crocineus*, USNM 220080, Philippines; *Mars caeruleomaculatus*, Field Mus., sta. no. LW-5, Gulf of Mannar, S. India; *Mars strigiliceps*, USNM 220083, Philippines, and USNM 220077, off Somali coast, Indian Ocean; *Vanderhorstia delagoae*, Acad. Nat. Sci. Philadelphia, sta. no. F-119, Seychelles; *Vanderhorstia ornatissima*, Acad. Nat. Sci., Philadelphia, sta. no. F-44, Seychelles.

*Vanderhorstia praealta*, new species

Figs. 1–2

*Holotype*.—USNM 215290, female, 35.5 mm SL, from Amirante Islands, D'Arros Island, off E side, at a depth of 18.3–30.5 m, 9 Mar. 1964, collected by D. Dockins, R. Rosenblatt, W. Starck, and J. Tyler, sta. F-109, International Indian Ocean Expedition, Seychelles Islands Program 1964, Academy of Natural Sciences of Philadelphia.

*Diagnosis*.—Related to *Cryptocentrus*-like gobies but variously different from them in the following characters: first dorsal fin very elongate and far forward on body, its length 62.5 percent of SL, spines I–III longest and about equal in length; scales of moderate size, about 54 in lateral series, cycloid; three horizontal rows of papillae on cheek; gill opening moderate; caudal fin longer than head length; dorsal fin VI–I,10; anal fin I,10; pectoral rays 18; head, nape, base of pectoral fin, and breast with numerous, small light spots; trunk plain, light brown; the fins mostly dark.

*Description*.—Dorsal fin rays VI–I,10; anal fin rays I,10; pectoral fin rays 18–18; pelvic fin rays I,5; segmented caudal fin rays 17; branched caudal fin rays 13; lateral scale rows 54; transverse scale rows 24.

Scales cycloid, smaller anteriorly on trunk; scales absent on cheek, opercle, base of pectoral fin, breast, and predorsal area; scales eccentric, focal area narrow, about 9–11 primary radii and 2–3 secondary radii in large anterior field, radii absent in posterior field.

Vertebrae 10 + 16; pterygiophore formula 3(22110).

The following measurements are expressed as thousandths of the SL: head length, 250; snout length, 54; bony interorbital width, 6; greatest diameter of orbit, 73; upper jaw length, 115; predorsal length, 290; greatest depth of body, 189; pectoral fin length, 299; pelvic fin length, 245; caudal fin length, 324; pelvic fin insertion to anal fin origin, 270; first to third spines of spinous dorsal fin longest and about equal, the second spine slightly longer, its length 625.

Head cylindrical; trunk somewhat compressed; interorbital narrow, much less than diameter of eye; lower jaw equal to upper jaw, the gape wide; length of jaw extending posteriorly nearly to vertical through posterior margin of eye; anterior and posterior nares close together, the anterior nares on a short tube; tongue truncate, the tip free; gill opening moderate, extending just below and anterior to lower insertion of pectoral fin, not reaching posterior margin of preopercle; first dorsal fin extremely elongate, about five times higher than second dorsal fin; first dorsal fin far forward, the insertion above pectoral fin base; first dorsal fin membrane free from second dorsal fin; origin of second dorsal fin anterior to a vertical through anal opening;

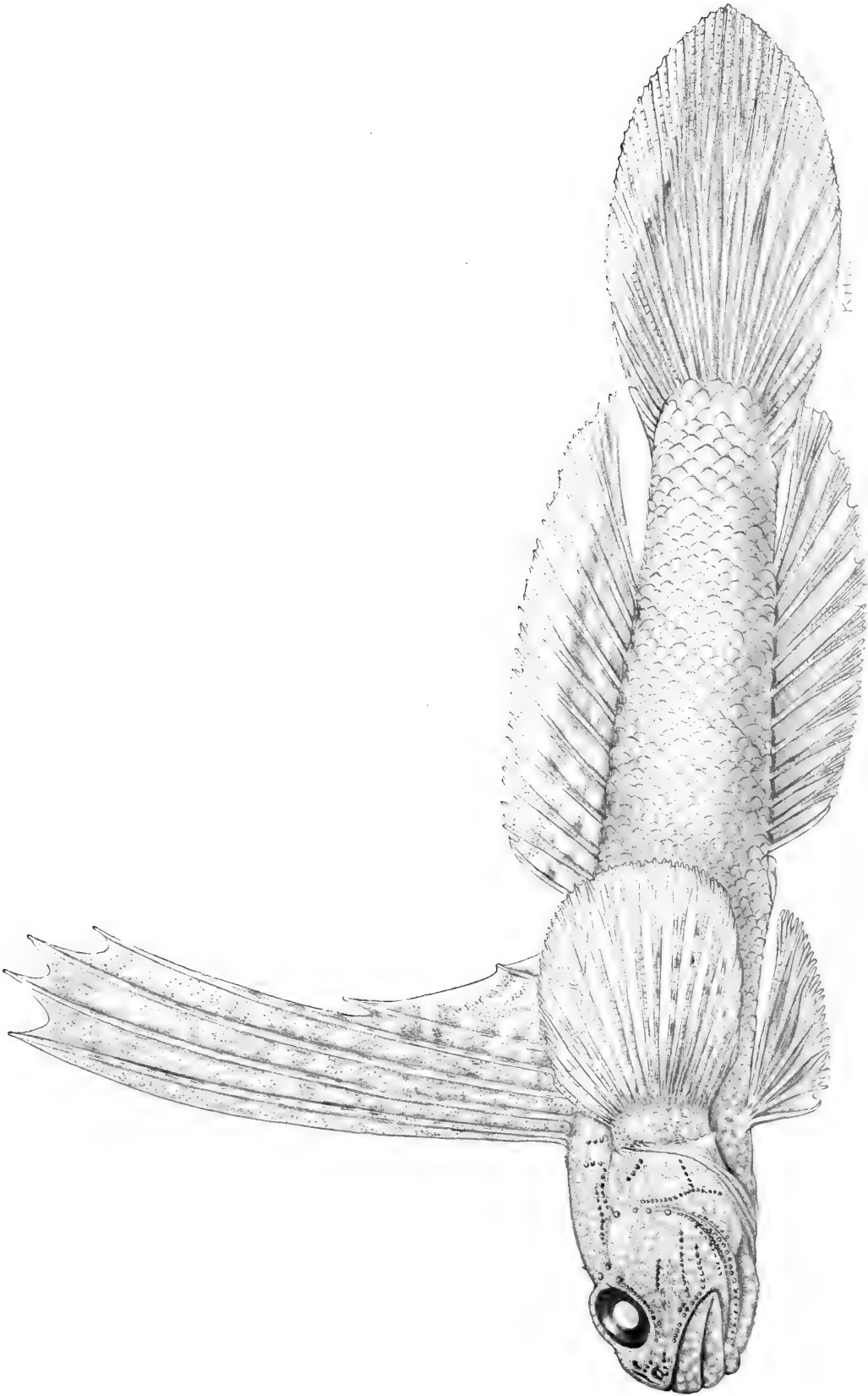


Fig. 1. *Vanderhorstia praealta*, USNM 215290, holotype, female, 35.5 mm SL, from Amirante Islands, western Indian Ocean. (Note:

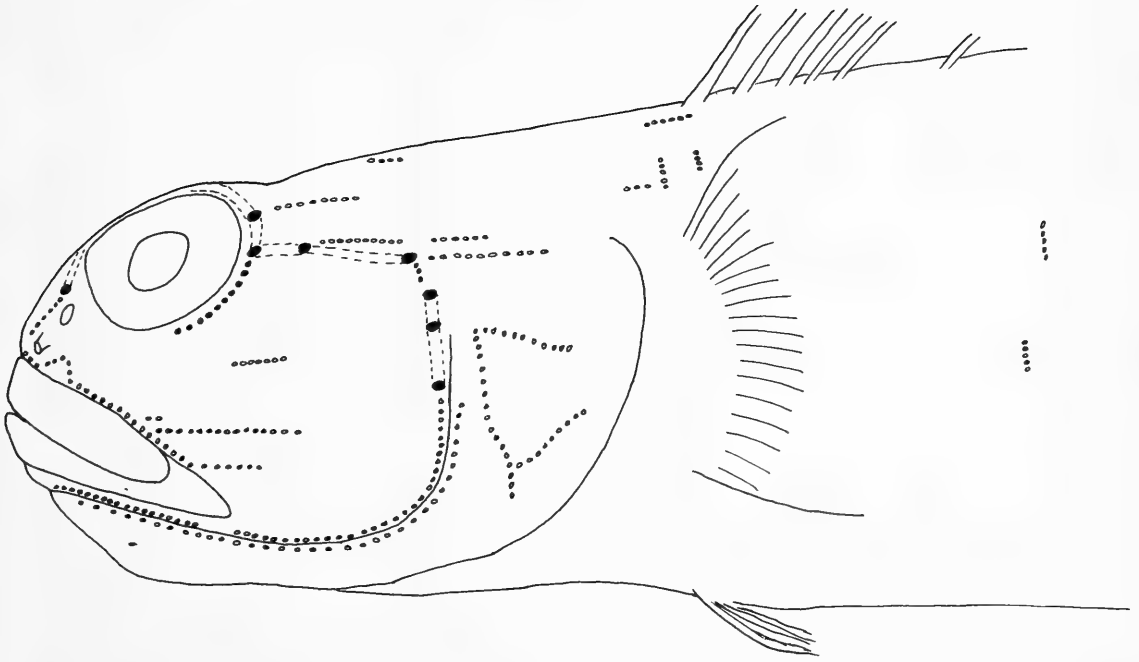


Fig. 2. Diagrammatic lateral view of head and anterior body of *Vanderhorstia praealta*, showing cephalic sensory pore and canal system (dashed lines and black spots) and sensory papillae (small open circles). Interorbital pores not shown. See Lachner and McKinney (1978) for pore and papillae terminology.

adpressed pectoral fin extends posteriorly to a vertical through anal opening; pectoral fin longer than deep, the posterior margin round; pelvic fin, when adpressed, reaches anal opening; pelvic frenum well developed, the inner pelvic fin rays connected to tip, the rays multibranched; anal fin as high as second dorsal fin; caudal fin longer than deep, longer than head, the posterior margin pointed; genital papilla bulbous, wider than long.

Teeth in upper jaw caninoid in four rows medially, reduced to two rows laterally; teeth in outer row about three times longer than those of inner row; teeth of lower jaw caninoid, in a patch of 3–4 rows medially and two rows laterally; those on outer row and laterally on inner row longest, about two times as long as the other teeth of lower jaw; no vomerine or palatine teeth.

The cutaneous papillae system consists of small structures in a few rows on the head and trunk (Fig. 2). The important diagnostic papillae consist of three short horizontal rows on the cheek and a suborbital row beneath the posterior half of the eye, terminating at the AOT sensory pore. There are no vertical papillae rows on the cheek. Other obvious rows of papillae are: a row above margin of upper jaw; short rows on snout anterior to NA pores and between them; two preoperculo-mandibular rows; a short lateral cephalic row extending posteriorly from the IT pore and a longer, secondary lateral cephalic row extending posteriorly from about the POT pore to above

the mid-opercular area; a short row extending posteriorly from SOT pore; a short row on each side of midline of nape; short, scattered vertical rows above insertion of upper pectoral fin; short, staggered, vertical rows on trunk, along midline and belly, each row encompassing about 2–3 scales; a row bordering the lower margin of the sixth and ninth segmented caudal fin rays and one on the upper margin of the twelfth segmented ray. The three rows on the opercle common to most gobies are present.

The cephalic sensory pore system consists of the following pores: paired NA, SOT, AOT, POT, IT and three POP pores, and unpaired AITO and PITO pores on the midline of the head. There is a deep, transverse groove immediately behind the eyes.

*Color in preservation.*—All of head except dorsal portion of occipital area with numerous, small, pale to white, circular spots over a light brown background. The pale spots are best developed on snout, lips, cheek and opercle. Pale spots are also on the breast and base of the pectoral fin. The trunk is uniformly light brown with fine, dark brown, pepper-like specks. The spinous dorsal fin is mottled in light and dark brown irregular markings; the lower half is light brown and the outer half darker brown. There are alternating, circular, pale spots and brownish areas on the lower two-thirds of the first five interradi al membranes of the soft dorsal fin; the posterior, lower two-thirds portion has pale elongate spots in one or two rows near the midportion of the fin; the remaining membrane and rays are brownish; the membrane and rays of the outer third of the soft dorsal fin are transparent; the interradi al membrane between the posterior-most two rays is brownish to black, much darker than the rest of the fin. The interradi al membranes of the anal fin are brownish to black, the rays are light brown. The outer margin of the anal fin has a narrow light border. The caudal fin has a pale, elongate mark distally on the upper five branched rays, and two small pale spots on the upper margin of the procurrent rays; the remainder of the fin membrane is brownish-black. The membrane between the longest rays in the middle portion of the caudal fin is darker brown; the rays of the fin are light brown. The pectoral fin has an alternating series of elongate brown marks and light areas basally on the rays, and these spots extend about two-thirds outward on the rays of the central portion of the fin; the membrane of the fin is pale; the outer half of the upper six rays is pale; the outer third of the rest of the lower portion of the fin is pale. The pelvic fin rays are pale and the interradi al membranes are brownish black. The first dorsal, second dorsal, pelvic, anal, and caudal fins are darker than portrayed in Fig. 1.

*Etymology.*—The specific epithet is taken from the Latin, *praealtus*, in reference to the unusually long first four elements of the spinous dorsal fin.

*Discussion.*—*Vanderhorstia praealta* superficially resembles two other species with high spinous dorsal fins, *Cryptocentrus pretoriusi* Smith (1959:193, fig. 5) and *Vanderhorstia mertensi* Klausewitz (1974:210, figs. 5–

7). *Cryptocentrus pretoriusi* has small scales, 100 in the lateral series; the third dorsal spine is longer than the first and second spines; the dorsal fin elements number VI-I,11 and the anal fin elements I,11; and the body coloration consists mainly of some large light spots on the head and midlaterally on the trunk. *Vanderhorstia mertensi* has intermediate sized scales, about 60 in the lateral series; the fourth spine of the spinous dorsal fin is longer than spines I-III and a large outer portion is free from the interspinous membrane; the dorsal and anal fins are long, dorsal fin elements number VI-I,16 and the anal fin elements I,17-18; and the body coloration consists of moderately sized light spots on the head, nape and on the dorsal fins, and several weak, dusky bars on the trunk. *Vanderhorstia praealta* has about 54 scales in the lateral series; spines I-IV are elongate, the tips connected by the interspinous membrane, and spines I-III are longest and about equal in length; the soft dorsal and anal fin elements number I,10. The dominant body coloration consists of small light spots on the head, nape, breast, and base of pectoral fin; the trunk is uniformly light brown and the fins are mostly dark colored, with the outer portion of the second dorsal fin and upper portion of the caudal fin light. Three species referred to the genus *Vanderhorstia* by several authors are treated in a key by Klausewitz (1974:211), namely *V. delagoae* (Barnard), *V. mertensi* Klausewitz and *V. ornatissima* Smith. *Vanderhorstia praealta* has a strikingly different color pattern from these species as well as having certain differences in meristic characters.

Polunin and Lubbock (1977:92), while working in the Seychelles, observed but did not collect a dark colored "*Cryptocentrus*" that had a high first dorsal fin; they stated that it may have been *C. pretoriusi*. This species may have been *V. praealta*.

### Acknowledgments

Figure 1 was rendered by Ms. Keiko H. Moore, NMFS, U.S. National Museum of Natural History, Washington, D.C. We thank Dr. James E. Böhlke, Academy of Natural Sciences, Philadelphia, for the exchange of the holotype resulting from this cooperative, international field collecting effort. Comparative material of various nominal genera of gobies was also received from the Academy of Natural Sciences, Philadelphia, and the Field Museum of Natural History, Chicago. Ms. Susan J. Karnella, U.S. National Museum of Natural History, provided valuable comments on the manuscript.

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SYMETHINAE, NEW SUBFAMILY, AND *SYMETHIS*  
*GARTHI*, NEW SPECIES, AND THE TRANSFER  
OF *RANINOIDES ECUADORENSIS* TO  
*NOTOSCELES* (RANINIDAE:  
BRACHYURA: GYMNOPLEURA)

Gary D. Goeke

*Abstract.*—A new subfamily, Symethinae, of the frog crab family Raninidae proposed for the reception of the genus *Symethis*, is detailed and compared with Ranininae in which *Symethis* formerly had been included. A Pacific species *Symethis garthi* is described and compared with the Gulf of Mexico species *Symethis variolosa*. The spermathecal pits of the genus are compared with other genera of Raninidae and illustrated. The taxonomic status of *Raninoides ecuadorensis* Rathbun is reviewed and it is transferred to *Notosceles* Bourne.

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The family Raninidae is a unique group of decapod crustaceans, characterized by exposed thoracic epimera, abdomen incompletely flexed under the cephalothorax and elongate thoracic nerve ganglionic mass. Other morphological features found within this group have recently been reviewed by Stevcic (1974). This family of crabs possesses many specialized adaptations which, combined with a superficial resemblance to albuneid "crabs," has led to a long history of confusion surrounding the systematic position of the group. They have been alternately classified among most of the major taxa of brachyuran crabs. This paper deals with the taxonomic status of 2 frog crabs which occur in the eastern Pacific.

I wish to express my appreciation to Drs. R. B. Manning (National Museum of Natural History, Smithsonian Institution), Gilbert Voss (Rosenstiel School of Marine and Atmospheric Science, University of Miami) and Janet Haig (Allan Hancock Foundation) for the loan of specimens. I am also indebted to Dr. Danièle Guinot (Muséum National d'Histoire Naturelle) for examining specimens of *Cyrtorhina granulosa*. Darryl Felder (University of Southwestern Louisiana), Richard W. Heard (Gulf Coast Research Laboratory), and John S. Garth (Allan Hancock Foundation) kindly reviewed the manuscript and Linda Lutz aided in preparation of the illustrations.

In a recent attempt to arrive at a satisfactory phylogenetic classification of the family, Serène and Umali (1972) recognized 2 subfamilies: Notopinae and Ranininae. Morphological features which define the subfamilies are relative sizes of the first and second male pleopods and the orientation of the

orbital sinuses. The crabs of the genus *Symethis* do not fit into either of the available subfamilies for the reasons enumerated below. A new subfamily, Symethinae, subfam. nov., is proposed for the reception of the Atlantic and Pacific species of *Symethis*.

*Symethis* is restricted to American waters and until now has contained a single species, *S. variolosa* (Fabricius, 1793), which ranges from North Carolina south to Bahia, Brazil, and through the Gulf of Mexico. This species was listed by Rathbun (1937:18) with a geographic range into the Pacific Ocean along the Panamanian coast. However, examination of specimens collected from that area has shown they represent a previously undescribed species formerly confused with *S. variolosa*.

Symethinae, subfam. nov.

*Diagnosis*.—Eyes greatly reduced; spermathecal pits widely separated with overarching hoods; 7 pairs of gills; palms of cheliped greatly inflated.

*Symethis* Weber, 1795

*Symethis* Weber, 1795:92.—Rathbun, 1937:24.

*Zanclifer* Henderson, 1888:34.—Bourne, 1922:66.

*Symethis garthi*, sp. nov.

Figs. 1; 2a, b; 3a–c

*Symethis variolosa* Rathbun, 1937:26, fig. 10, pl. 5, figs. 7, 8 (in part).—Correa, 1970:10, pl. 5, figs. 38–47, pl. 6, figs. 48–55, pl. 7, figs. 60–61 (in part).

*Diagnosis*.—Carapace heavily eroded, hepatic spines blunt, well developed; abdominal segments coarsely granulate anteriorly; dactyls of ambulatory legs 1 and 2 with flattened spine at base of lunate curvature; dorsal teeth of carapace blunt.

*Description*.—Carapace eroded, generally oval in shape, convex front to back and side to side; length of carapace 1.64 times width. Rostrum produced beyond general outline of carapace into trilobed process with diminutive eyes at base; eyestalks retract slightly into cup-shaped socket formed by small lateral and ventral outfoldings of carapace and upper margin of basal antennal article; eyes calcified anteriorly, completely protected and concealed when retracted. Rostrum deeply eroded medially at base, floor of depression with numerous raised tubercles. Eroded depressions of carapace spread posteriorly and laterally, forming symmetric depressions over anterior two-thirds of carapace; floor of depressions occasionally with well-developed tubercles. Fronto-orbital region demarcated by elevated transverse ridge (often interrupted by depressions) which connect hepatic spines;

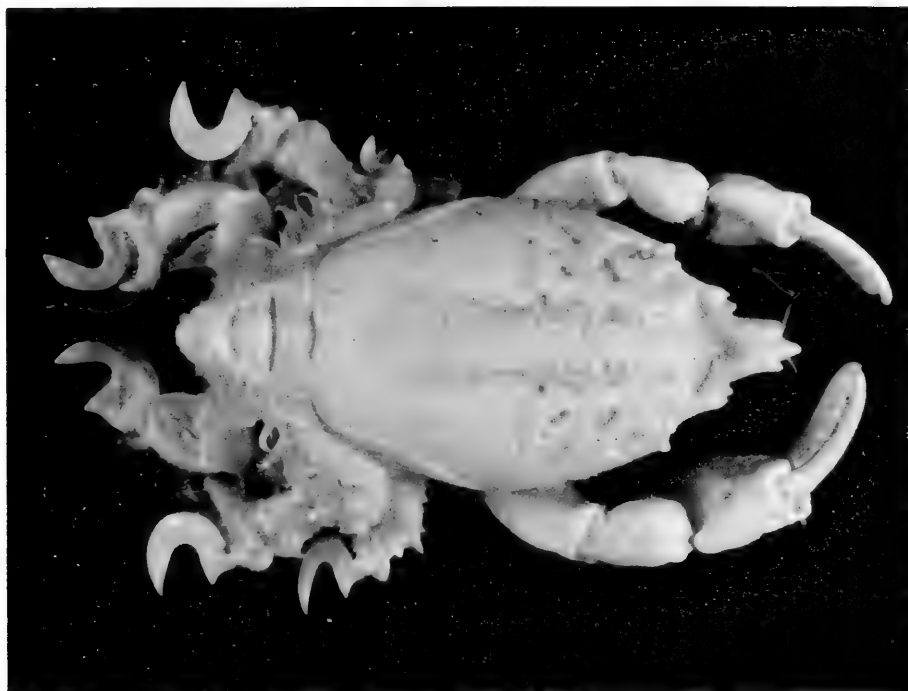


Fig. 1. *Symethis garthi*, holotype ♂, dorsal view.

rostrum lying on lower level than remainder of carapace. Anterolateral margin of carapace with well developed blunt hepatic spines behind which setae become evident laterally. Posterolateral margins of carapace bordered by slight ridge, obvious in dorsal view, terminating posteriorly at base of abdomen. Carapace widest about two-thirds of way from front. Abdomen with 7 segments, only slightly deflexed so that 4 or 5 segments are evident in dorsal view; all segments with very dense setae laterally. First abdominal segment four-fifths as wide as posterior margin of carapace, ornamented with coarse granules anteriorly. Remaining somites of abdomen decreasing in width, all with prominent tubercles; setae forming row dorsally on posterior 5 segments. Penultimate abdominal somite with short, posterolateral extensions, last somite rounded.

Merus of first leg massive with concave inner border, covered with setae proximally. Carpus heavy and minutely eroded with small tubercles; distally with rounded mound of small tubercles forming complex network on bulbous palm of chela; fixed finger slightly deflexed with granules forming parallel longitudinal rows. Broad dorsal carina extending distally on dorsal surface of manus, becoming much broader than base of movable finger. Propodus and fixed finger with numerous large teeth which mesh with tip of propodus interior to fixed finger. Propodus moderately developed, also with parallel rows of granules.

Second leg fringed extensively with setae; carpus tuberculate dorsally

with 2 distal outfoldings to form spatulate processes. Propodus short, with 4 spatulate processes on distal margin; dactyl of second leg flat, lunate, with spine at base. Third leg similar except carpus with 2 small processes and numerous larger rounded spines; propodus with 1 spatulate process and series of spines extending out onto posterior extension of segment; dactyl flat and lunate with spine produced at base. Merus and carpus of fourth leg dorsally tuberculate; propodus with large curved spatulate process on interior margin, dactyl flat, lunate, fringed with setae. Fifth leg greatly reduced, dorsal in position; all segments heavily tuberculate dorsally with serrate margins; posterior margin of propodus with curved spatulate process, dactyl flat, lunate, fringed with setae.

Ischium of third maxilliped greatly elongated, 2.5 times length of merus, paved with low granules; merus short, slightly longer than wide, covered with low tubercles except in central region where floor of depression is clear; palp not evident in ventral view. Exognath of third maxilliped slightly shorter than ischium. Sub-hepatic region of carapace with eroded depressions, floor of depressions with numerous tubercles, produced anteriorly into 2 large mounds, 1 forming lateral margin of pocket surrounding eye. Antennal peduncle massive, produced into 2 lobes, 1 projecting ventrally and 1 extending anteriorly almost to tip of rostrum. Antennule very small and not obvious in ventral aspect.

*Material examined.*—Holotype: USNM 173452, 31 March 1939, M. S. Stranger, collector, Gulf of California, Espiritu Santo 2, Mexico, 24°26'50" N, 110°18'W, 11–36 m, male 33.3 mm. Paratypes: USNM 173453, collected with holotype, 10 males, 10 females, 1 carapace, 13.8–35.0 mm. USNM 155089, 14 April 1939, M. S. Stranger, collector, Gulf of California, Puerto Refugio, 29°32'17"N, 113°33'50"W, 18–27 m, 3 males, 1 female, 22.8–25.5 mm. AHF 3513, 6 February 1935, Velero III station No. 458-35; W. L. Schmitt, collector, Secas Isle, Panama, 7°57'55"N, 82°02'W; 9–27 m, 1 male, 13.6 mm.

*Etymology.*—This species is named in honor of Dr. John S. Garth (Allan Hancock Foundation), whose work has done much to further crustacean knowledge.

*Remarks.*—*Symethis garthi* and *S. variolosa* are closely related species restricted to American waters. In the Gulf of Mexico, *S. variolosa* occurs only on substrates of shell and shell hash (Goeke, unpublished data). *S. garthi* may also occur most frequently on shell bottoms although specimens from Panama were collected from substrates of mud and sand. Sediment information obtained from original collection tag of the type specimen indicates a sand and shell bottom close inshore. Offshore, coral and rocky bottom is reported; however, it is not known from which bottom type the material was collected. The very few specimens of *S. garthi* available suggest highly restricted populations in the Pacific or the species is not easily collected by usual methods.

The genus *Symethis* has been placed within the subfamily Ranininae by Serène and Umali (1972:25) along with *Ranina* Lamarck, 1801, *Lyreidus* de Haan, 1841, *Notopoides* Henderson, 1888, *Raninoides* H. Milne-Edwards, 1834, *Notosceles* Bourne, 1922 and *Cyrtorhina* Monod, 1956. The characters which define the subfamily are: eye peduncle folded obliquely or longitudinally forward; and male pleopod 2 with elongated, tapering shaft shorter than pleopod 1 (Serène and Umali, 1972:34); apex of male pleopod 2 usually ornamented distally.

Recent work by Hartnoll (1979) has centered on the structure of the spermathecal pits of the raninids and casts some doubt on the validity of the 2 subfamilies. The work has shown no correlation between the subfamilies Ranininae and Notopinae and spermathecal structure of the females. The spermathecal pits of this family have been commonly characterized as a single, unpaired median pit. Gordon (1966) noted the presence in *Ranina* and *Notopoides* of what she thought to be an unpaired spermathecal pit. Hartnoll (1979) has shown that the spermathecal pits of this group are indeed paired but often recessed to the bottom of a pit-like depression present in the anterior part of sternite 7. The depression had mistakenly been described as a single spermathecal pit. The structure of spermathecal pits in this family has been thought to form a continuum, beginning with that characterized by *Lyreidus* through the form exemplified by *Ranilia* to *Raninoides* and *Notosceles* (Hartnoll, 1979:80). However, the spermathecal pits of the genus *Symethis* must be inserted within this grouping. It can be modified so that the progression now proceeds from *Symethis*, through *Lyreidus* and *Ranilia* to the recessed form of *Raninoides* or *Notosceles*.

Of the 10 genera currently recognized within the family Raninidae, the spermathecal pits have been described in 5 by Hartnoll (1979). Gordon (1966) illustrated the spermathecae of *Notopoides* and those of the 4 genera which remain are described here.

The spermathecae of *Ranilia* agree closely with those described for *Ranina*. The sternal shield between pereopods 3 and 4 is constricted with paired spermathecae obvious upon close examination. The anterior part of sternite 7 contains a median pit with a trough-like depression proceeding posteriorly. The anterior walls of the spermathecal depression are steep-sided with the pits covered by a flexible membrane as in *Ranina*.

*Notosceles* conforms with that form of spermatheca described for *Raninoides*. The spermathecae are not obvious, but dissection shows them to be located at the bottom of the deep pit-like depression. The pit is circular in ventral view with steep-sided walls on all sides. No trough is evident posteriorly and the median depression occupies most of the area of the sternal shield between pereopods 3 and 4.

Specimens of the genus *Cyrtorhina* were not available but at the request of the author were examined by Dr. Danièle Guinot (Muséum National d'Histoire Naturelle). She has described a single median pit located on the

anteriormost section of sternite 7. Similar to that found in *Ranina*, the pit is steep-sided anteriorly with indications of a trough-like depression posteriorly.

The spermathecae of *S. garthi* (Fig. 2a) differ greatly from those described for the other genera of frog crabs. The spermathecal openings are situated partly on the suture of sternite 7. There is no indication of a median trough as in *Lyreidus* or *Ranilia* and the spermathecal openings are large and widely separate. Obvious features are the calcified hoods which arch over the spermathecal openings in such a manner as to make them approachable only from the posterior. A decalcified flap is present below the "hood" in *Symethis* as in most of the remaining genera. *Symethis variolosa* from the Gulf of Mexico agrees very closely with this description in the structure of the spermathecal pits. Slight differences in the calcified hood over the opening may be of specific value.

In the Gulf of Mexico, females of *S. variolosa* are often collected with the spermathecal openings completely occluded by an amorphous plug of hardened material. In alcohol, the hardened mass completely occupies the area of the sternal shield between pereopods 3 and 4 obscuring the spermathecae. This "plug" effectively seals off the pits and may be the result of the packing of the spermathecae with sperm packets by the male after mating. Excess sperm packets transferred during copulation would remain outside the spermathecal openings and may harden on exposure to sea water, effectively preventing the female from mating with a second male. Over 60% of the adult females collected in the Gulf show this condition (Goeke, unpublished data). Eight of the 11 females of the Pacific species examined are also plugged in this manner.

Crabs of the genera *Cyrtorhina* Monod and *Symethis* Weber resemble each other and are considered most closely related by Serène and Umali (1972:49). No evidence was cited by Serène and Umali to support the statement, although the dactyls of the pereopods and the frontal regions of the carapaces are very similar. Monod (1956:49) states that *Cyrtorhina* is closer to *Ranina* and details how the genera differ. It is my opinion that the resemblance between *Cyrtorhina* and *Symethis* is superficial. Considerable differences are immediately obvious in a comparison of the pleopods and female spermathecae of *Symethis* and *Cyrtorhina*. The first male pleopods of *Cyrtorhina* (Monod, 1956:52) are short and stout, much more closely resembling those of *Ranina* as figured by Barnard (1950:398) than the very broad type of pleopod of *Symethis* (Fig. 3).

The spermathecae of *Cyrtorhina* and *Ranina*, as described previously, are also in close agreement. In both genera, the structure of the spermathecal pits consists of a deep, steep-sided pit in the anterior part of sternite 7. A depression extends posteriorly which becomes increasingly shallower toward the eighth sternal plate. This form of spermatheca lies about midway

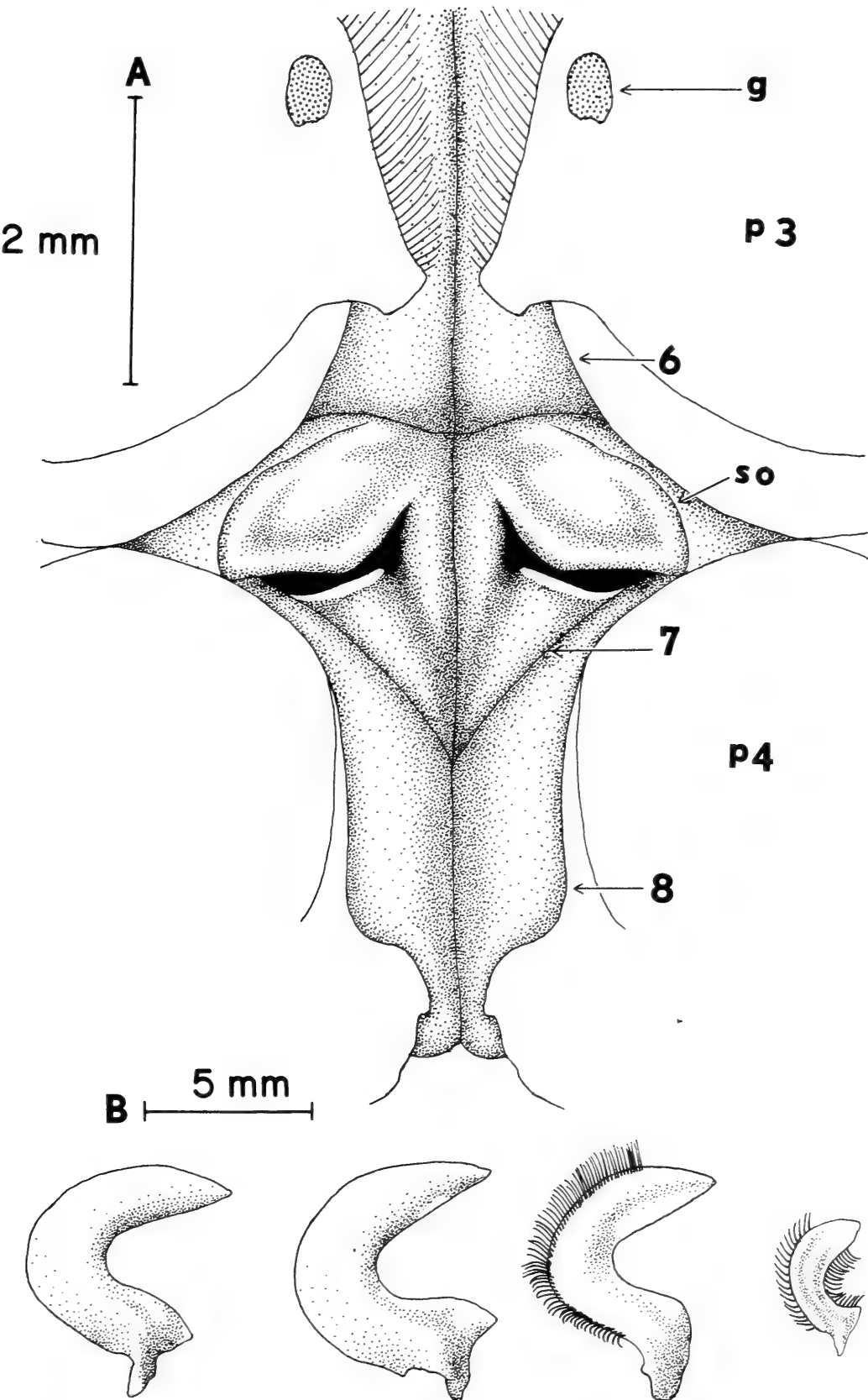


Fig. 2. *Symethis garthi*: A, Spermathecal openings, paratype ♀ (g, genital opening; p3, p4, pereopods 3 and 4; so, spermathecal openings; 6, 7, 8, sternites 6, 7, and 8); B, Dactyls of pereopods 2–5 (left to right).



in the series of structures found within this family. The spermathecae of *Symethis* are described above and can be considered a basically different form of spermatheca.

As noted by Stevcic (1974) the first male gonopods of the subfamily Ranininae are characteristically ornamented distally. This is well documented as the male pleopods of all the genera of the subfamily have been illustrated: *Raninoides* and *Notosceles* by Serène and Umali (1972), *Lyreidus* by Griffin (1970), *Ranina* by Barnard (1950), *Notopoides* by Gordon (1966), *Cyrtorhina* by Monod (1956) and *Symethis* by Correa (1972) and present paper (Fig. 3a, b). In all genera of the subfamily except *Symethis*, the distal part of the first male pleopod is ornamented with either broad spine-like projections or complex folds of tissue. In *Symethis*, however, the first male pleopod has no spines or folds distally. It is highly compressed laterally with the distal portion acuminate. The abundant tufts of setae on the anterior and posterior margins almost obscure the sharply tapering tip. This character supports the separation of the genus *Symethis* from the remaining genera of the subfamily.

Perhaps the most astonishing difference between *Symethis* and the other genera of the family is a difference in the number of gills. In *Symethis* the number of pairs of gills is only 7, all of which lie in the normal vertical position, with the anteriormost pair greatly reduced. In the remaining genera of frog crabs the gills number 8 pairs. *Raninoides louisianensis* Rathbun possesses 8 pairs of gills as does *Lyreidus*, *Ranilia* and *Notosceles*. In these forms, the anteriormost 2 pairs of gills are reduced in size but are large enough to be easily observed. The anterior 2 pairs are most likely still effective in oxygen exchange.

The reduced number of gills present in the genus *Symethis* represents a major departure from the remaining genera of the family Raninidae. This feature is of considerable taxonomic value and is a conservative character often used in the diagnosis of families. Much importance is attached to the respiratory mechanisms in this family and was stressed by Bourne (1922) in his account of the physiology of this group. Very little information is available on the life histories and ecology of the raninids; however, it is probable that the reduced number of gills is an adaptation to the niche occupied by this genus. Stevcic (1974) stated the reduced number of gills in this and other groups of crabs (i.e., Calappidae, Leucosiidae) is a modification for burrowing.

The differences in the number of gills and the spermathecae are sufficient to warrant the establishment of the proposed subfamily Symethinae. Future research may show that the subfamily deserves elevation to the rank of family. Subsequent work on this group should concentrate on the larval development of *Symethis*. The structure of the nervous system and fossil

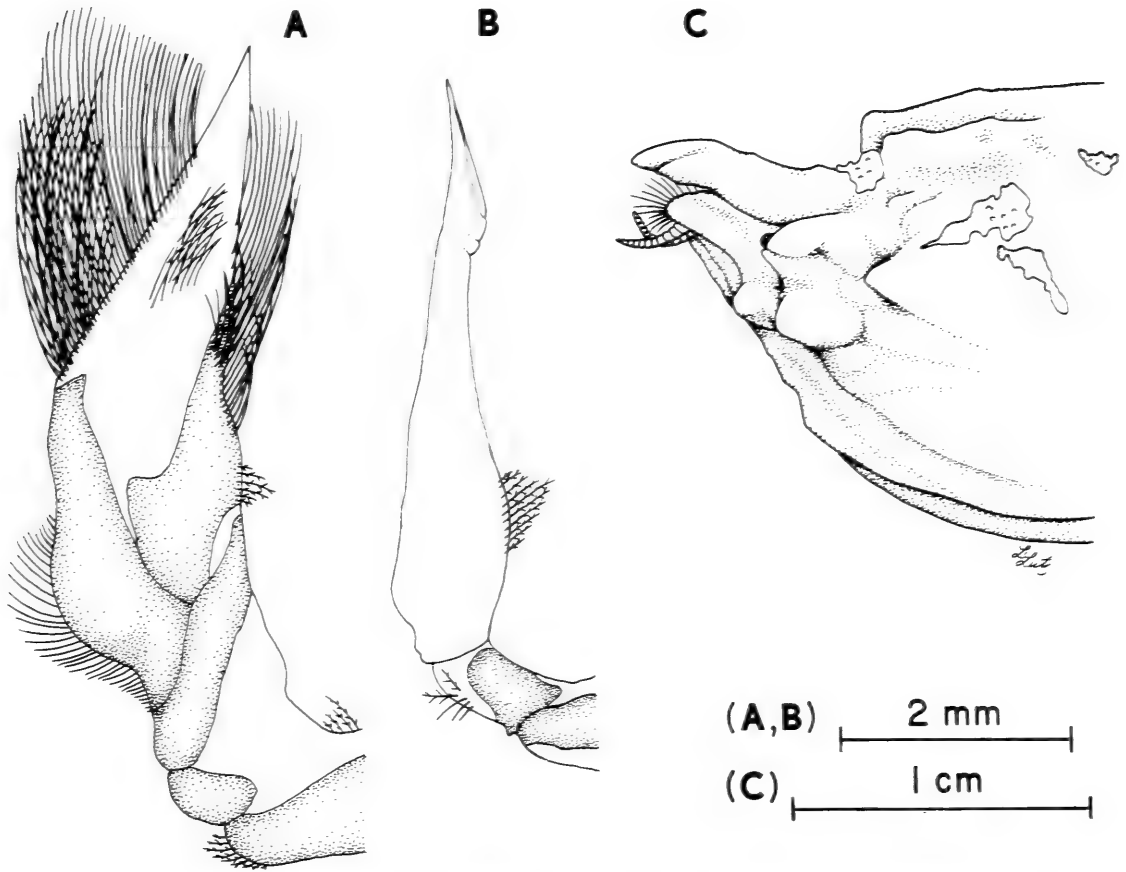


Fig. 3. *Symethis garthi*: A, First pleopod; B, Second pleopod; C, Lateral view of anterior part of carapace of holotype ♂.

history should be examined for support of the separation of this genus from the others within the family.

*Notosceles ecuadorensis* Rathbun, nov. comb.

The genus *Notosceles* was erected by Bourne (1922) for *N. chimmonis* in his account of the physiology of the family Raninidae. Other species subsequently assigned to the genus are *N. serratifrons* (Henderson, 1893), and *N. viadari* Ward, 1942. In establishing the genus, Bourne (1922) listed many characters which he used to differentiate *Notosceles* from the closely related *Raninoides*. Some features he listed were later questioned by Chopra (1933) who doubted the validity of the genus and suggested that it should be considered a synonym of *Raninoides*. Serène and Umali's (1972) work on the Philippine raninids dealt with this matter and attempted to define characters separating the 2 genera. For this study, *Notosceles ecuadorensis* was compared with 2 species of *Raninoides*: the type-species of the genus,

*R. loevis*; and *R. louisianensis*. Some of the following characters are those recognized by Bourne (1922) and others were utilized by Serène and Umali (1972). All represent characters that can be of value to separate *Notosceles* from *Raninoides*: 1) anterior end of carapace roughly granulate; 2) eyes of *Notosceles* shorter and stouter; 3) fronto-orbital width half of the extraorbital width of the carapace; 4) eyes slightly longer than rostrum; 5) no spine on ischium of cheliped; 6) truncate third maxilliped in *Notosceles* with shorter ischium to merus length than *Raninoides* (1.58 in *N. ecuadorensis* and 1.33 in *R. loevis*); 7) propodus of cheliped with double crested carina dorsally; 8) sternal shield not produced into acute spine between bases of pereopods 1 and 2; 9) rostrum pointed with 2 flat lateral teeth at base; 10) first abdominal tergum approximating width of posterior margin of carapace, with second shield about as broad; 11) fifth pereopod less massive than that of *Raninoides*; and 12) basal segment of the antennular peduncles broader than in *Raninoides*.

*Raninoides ecuadorensis* was described from material gathered off La Plata Island, Ecuador in 82–101 m. Originally included within the genus *Raninoides* Milne-Edwards, a recent examination of type-material has shown the species would be more properly included in the genus *Notosceles* Bourne, 1922. The material examined consisted of the type male (USNM #69319) and two lots of specimens collected from the type-locality (USNM #69320 and 81933). Supplemental material from the University of Miami (32:3437) was also examined. *Raninoides ecuadorensis* more closely agrees with the generic description of *Notosceles* given by Bourne (1922) and amended by Serène and Umali (1972). It is here designated *Notosceles ecuadorensis* (Rathbun, 1935), nov. comb.

With the transfer of *R. ecuadorensis* to *Notosceles*, 5 species of the genus *Raninoides* are known to occur in American waters. Four of the species are present in the western Atlantic with a single species, *R. benedicti* Rathbun, 1933, in the eastern Pacific. Two additional species, *R. fossor* A. Milne-Edwards and *R. nitidus* A. Milne-Edwards, 1880, have been recently synonymized and removed from species known to occur in American waters. Manning (1975) has shown *R. fossor* to be a junior synonym of *Notosceles chimmonis* Bourne, 1922, and Goeke (1980) removed *R. nitidus* to the genus *Lyreidus* as a synonym of *L. bairdii* Smith, 1881.

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*PARAMUNNA QUADRATIFRONS*, NEW SPECIES,  
THE FIRST RECORD OF THE GENUS IN THE  
NORTH PACIFIC OCEAN (CRUSTACEA:  
ISOPODA: PLEUROGONIIDAE)

Ernest W. Iverson and George D. Wilson

*Abstract.*—*Paramunna quadratifrons* n. sp., described from the southern California borderland, represents the first record of the genus in the north Pacific Ocean.

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The asellote isopod genus *Paramunna* is predominantly a southern hemisphere Antarctic and sub-Antarctic genus with a few north Atlantic Ocean representatives. Most records of *Paramunna* are from intermediate depths of the continental shelf and slope regions while a few species occur in the deep sea. Pacific Ocean records were previously limited to those reported by Menzies (1962) from off southern Chile. The species described here is the first *Paramunna* reported from the north Pacific Ocean. This single record is not surprising in view of the relative rarity of pleurogoniids in both population sizes and number of species in the northern hemisphere (Wilson, 1980).

This paper is based on material collected during the second year benthic survey of the southern California borderland (Fauchald and Jones, 1978) in connection with the Southern California Baseline Studies and Analysis program (FY 1977). All specimens were collected from a single spade corer sample (0.16 m<sup>2</sup> surface area) taken at a depth of 197 meters on North-West Tanner Bank, approximately 130 kilometers southwest of Los Angeles, California. Drawings were made with the aid of camera lucida and checked for detail at magnifications up to 430 power.

Pleurogoniidae Nordenstam, 1933, *sensu* Wilson (1980)

*Paramunna* G. O. Sars, 1866

*Type-species.*—*Paramunna bilobata* Sars, 1866.

*Diagnosis.*—Body broad, flat, tergal plates extending laterally well beyond coxae. Cephalon often with anterior protuberances: knobs, spines, or flattened curved plates. Lateral margin of pleotelson always with spines. Antenna article 3 with spines or knobs. Mandibular molar distally truncate.

*Remarks.*—This diagnosis should be regarded as preliminary until the genus is properly revised. However, the above concept is more restricted than the one currently recognized in the literature (e.g., Menzies, 1962).

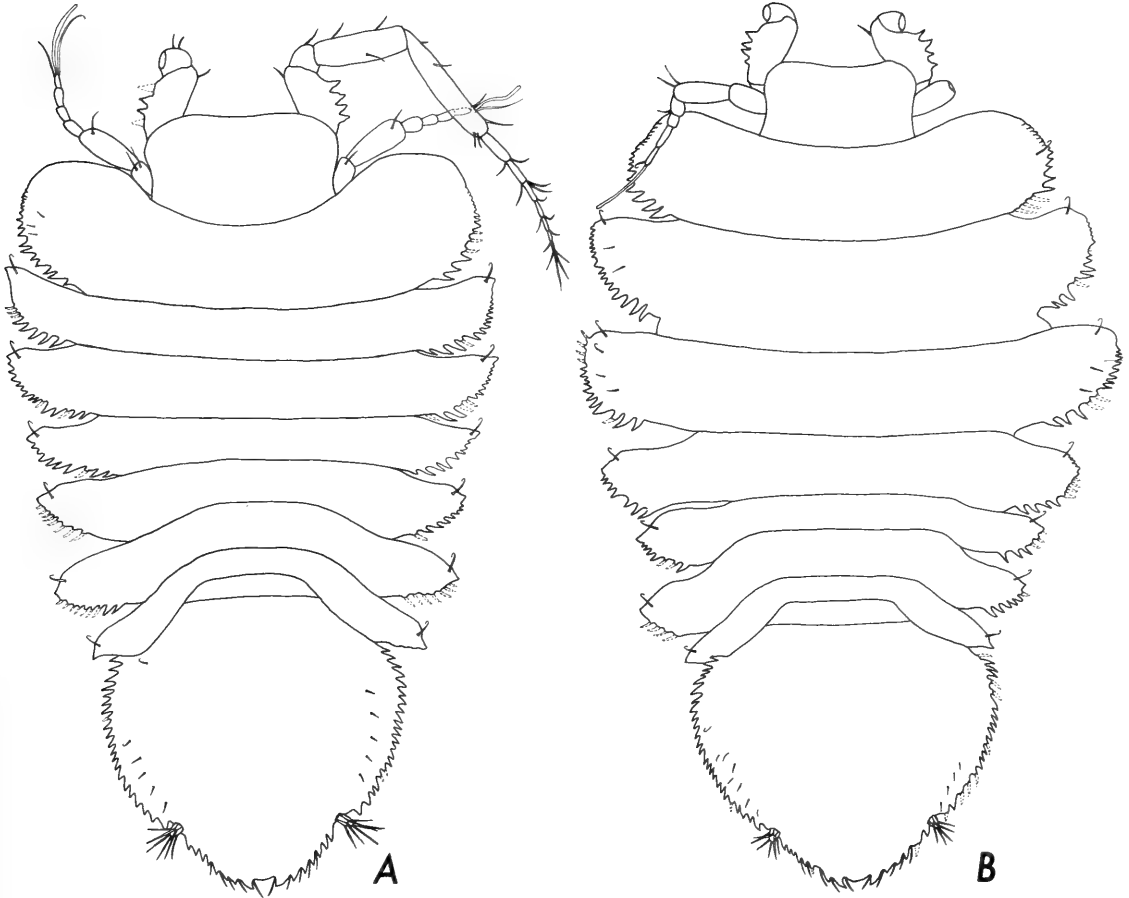


Fig. 1. *Paramunna quadratifrons*: A, Male holotype; B, Female allotype.

Consequently, some species should probably be returned to *Austrimunna* (Wilson, 1980).

*Paramunna quadratifrons*, new species

Figs. 1–4

*Material examined*.—Station 81832, 197 m, 33°53.24'N, 119°23.35'W, 4 males and 3 females from a light brown, coarse sand and shell sediment, collected 24 August 1978 by the R/V *Thompson*. Holotype male 1.23 mm body length (USNM 173915), allotype female 1.29 mm body length with 4 eggs (USNM 173916) deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. Paratypes have been deposited as follows: 1 male (CASIZ 015902) and 1 female (CASIZ 015903), California Academy of Sciences, San Francisco, California, and 2 males and 1 female (AHF 781), Allan Hancock Foundation, University of Southern California, Los Angeles, California.

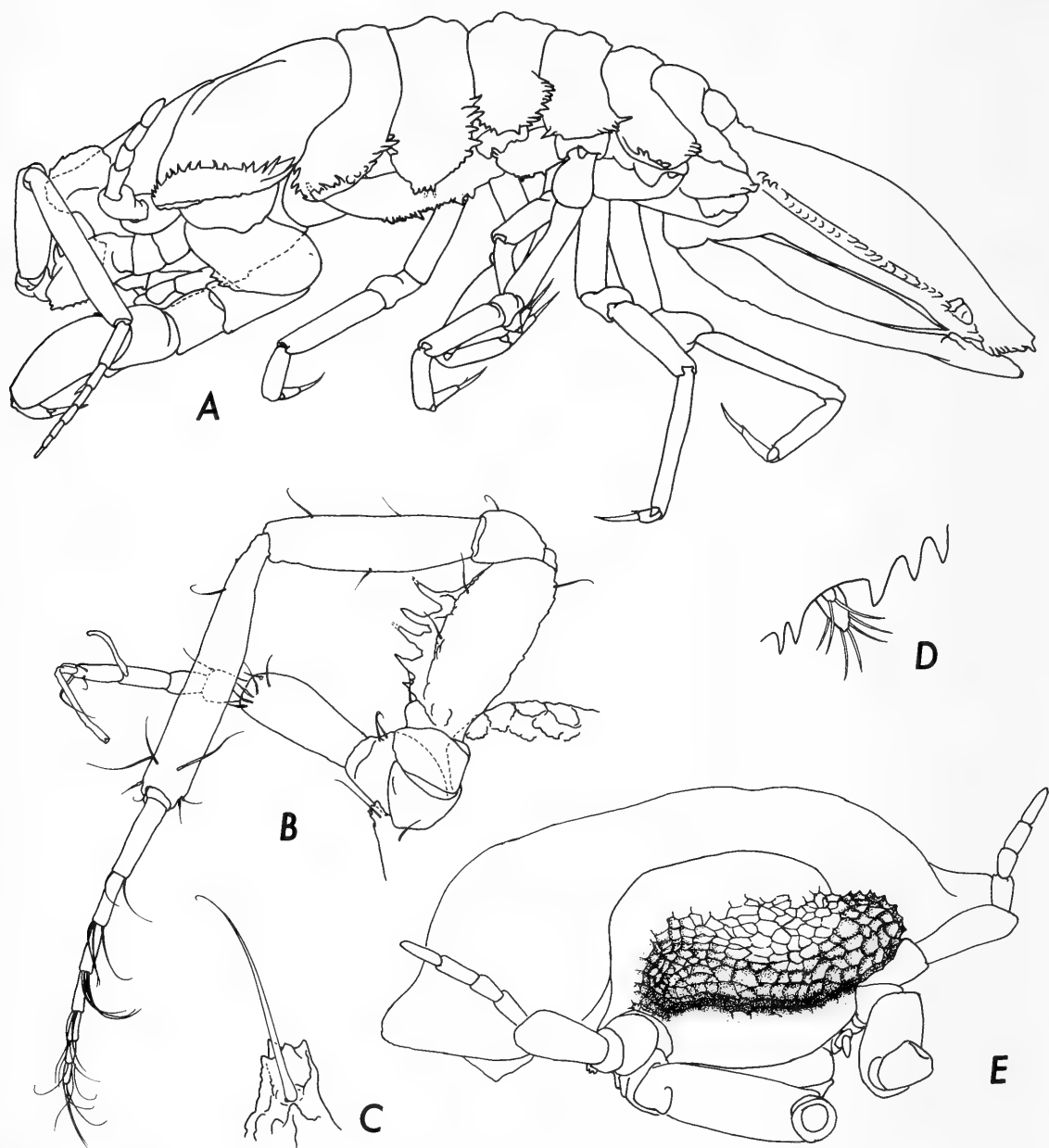


Fig. 2. *Paramunna quadratifrons*, male: A, Lateral habitus; B, Lateral margin of cephalon with antennula, antenna and ocular peduncle; C, Ocular peduncle; D, Right uropod; E, Cephalon, anterior oblique view, cuticular structures shown only on rostral lobe.

**Diagnosis.**—Cephalon anterior margin expanded into large plate-like shelf, somewhat concave dorsally, anterolateral angles rounded, more robust in male. Eyes absent, ocular peduncles very reduced. Lateral margins of pereonites heavily denticulate, a small hooked seta dorsally near apex of each pereonite. Antenna third article with 4–5 (typically 4) teeth dorsally.

**Supplemental description.**—Body broadest anteriorly at pereonite 2, tapering posteriorly. Pereonite 1 more robust in male compared to female,

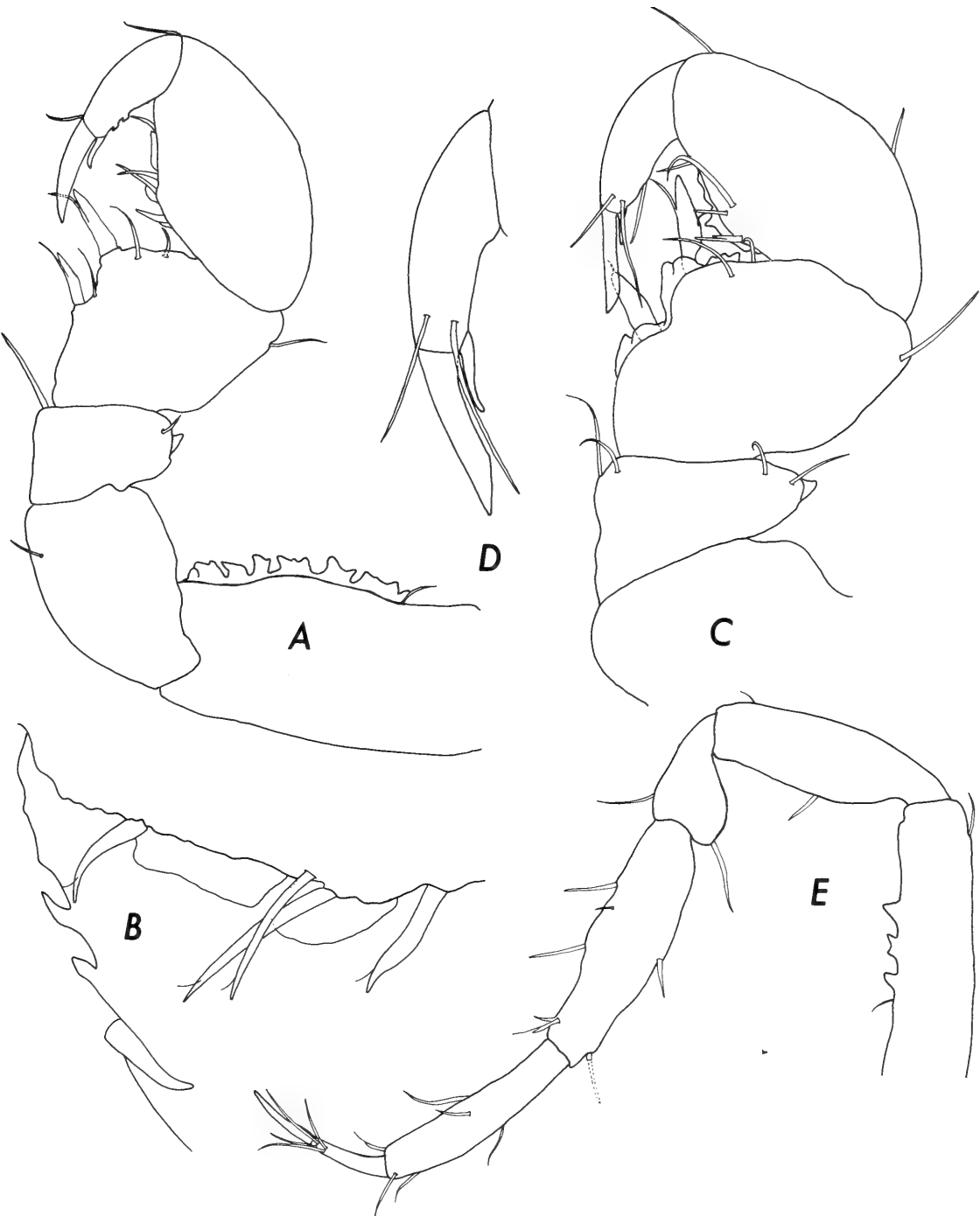


Fig. 3. *Paramunna quadratifrons*, female: A, Pereopod 1; B, Inner margins of pereopod 1 dactylus and propodus. Male: C, Pereopod 1; D, Pereopod 1 dactylus; E, Pereopod 7.

lateral margin truncate; pereonites 2–4 also sexually dimorphic, noticeably lengthened in ovigerous female, laterally truncate, in male acutely pointed; pereonites 5–7 laterally acute in both sexes. Pleotelson pyriform, somewhat concave at point of uropod attachment; apex rounded.



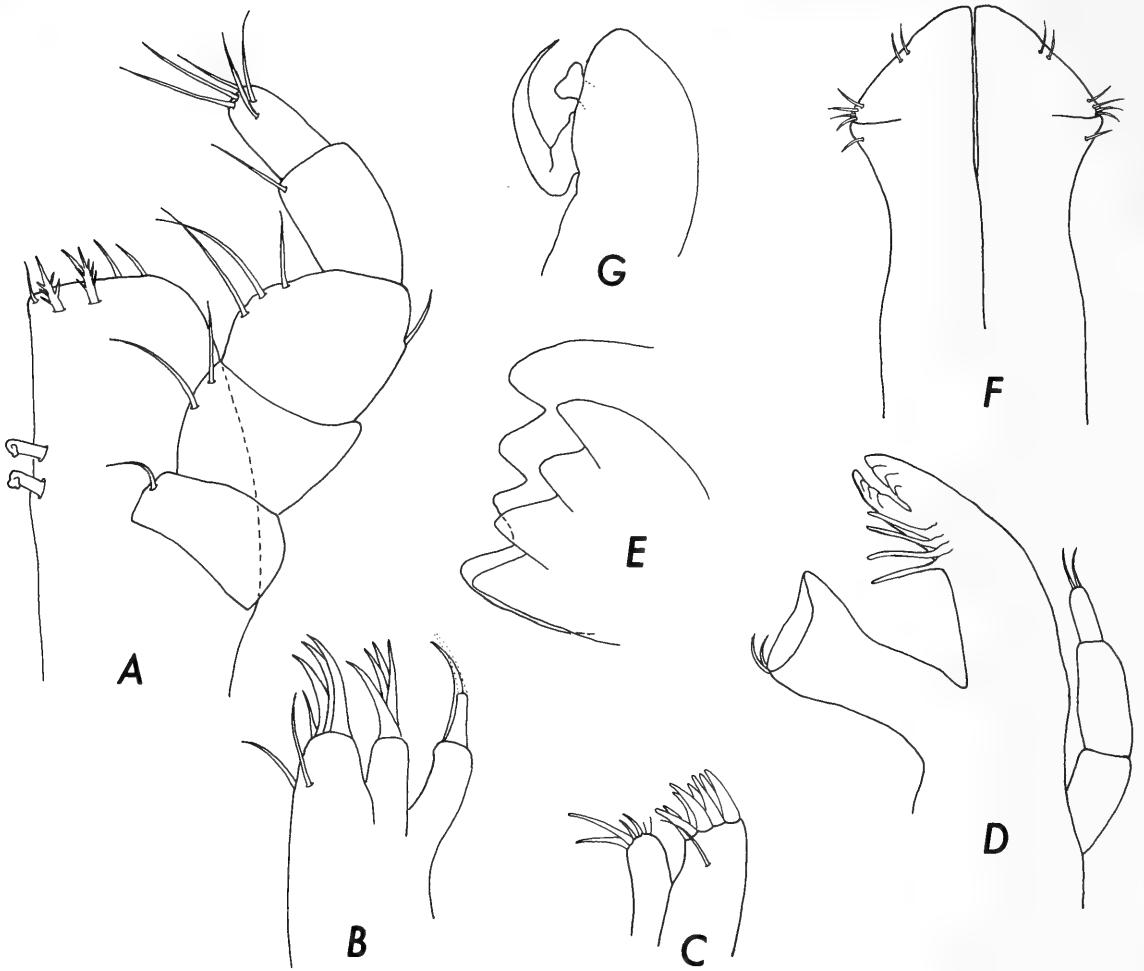


Fig. 4. *Paramunna quadratifrons*: A, Maxilliped; B, Second maxilla; C, First maxilla; D, Left mandible; E, Incisor process and lacinia mobilis of same; F, Male pleopod 1; G, Male pleopod 2.

Antennula with 6 articles; third, fifth and sixth articles subequal in length, fourth shortest; terminal article tipped with several setae and single long aesthetasc. Antenna flagellum with 6–8 articles.

Maxilliped: Endite with 2 coupling hooks, palp articles 2 and 3 much broader than articles 4 and 5, distal article about three-fourths length of fourth article. First maxilla outer lobe apically with 8 stout setae, inner lobe apically with 2 long and 2 short setae. Second maxilla bilobed, inner lobe with 4 apical and 2 subapical setae; inner lappet of outer lobe with 4 setae, outer lappet with 2.

Left mandible: Incisor process and lacinia mobilis each with 4 teeth, setal row with 4 simple setae; molar process cylindrical, distally truncate; distal article of palp short, about half length of middle article, with 2 short setae apically.

Pereopod 1 strongly subchelate, more robust in male; claw of dactylus chisel-like, propodus inner margin armed with about 4 small unequally bifid setae, carpus armed with 2 large unequally bifid setae. Pereopods 1–3 with denticles on bases. Pereopods 2–7 similar, not notably lengthened posteriorly.

Male first pleopod sagittate, medially fused for about three-fourths length, distal tip broadened laterally into bifurcate lateral corners each with tuft of several short setae, apex posteriorly pointed. Uropods biramous, basal article absent, inserted on lateral margin.

*Remarks.*—The extreme reduction of the eyes and ocular peduncles indicates that this species has its evolutionary roots in the deep sea (Hessler *et al.*, 1979). It is likely that this species or its ancestors migrated through the deep sea from the Antarctic center of pleurogoniid diversity (Wilson, 1980) to its present location. By this reasoning *Paramunna quadratifrons* is an emergent species.

The fact that seven individuals were collected in only one of the 8 replicate cores taken at the North-West Tanner Bank station suggests a very patchy distribution. Isopods collected in the same spade core sample with *Paramunna quadratifrons* include: *Ilyarachna acarina* Menzies and Barnard, an upper continental slope representative of a predominately deep-sea genus, and *Silophasma geminatum* (Menzies and Barnard), a continental shelf species which is widespread throughout the southern California bight. The pleurogoniid, *Pleurogonium californiense* Menzies was collected in another replicate.

*Etymology.*—The specific name *quadratifrons* is a combination of the Latin words *quadratus* meaning squared and *frons* meaning forehead, referring to the anterior margin of the cephalon.

### Acknowledgments

This study was, in part, supported by the Southern California Baseline Studies and Analysis program (FY 1977) funded by the Bureau of Land Management (U.S. Department of the Interior), contract number AA550-CT6-40 with Science Applications, Inc., La Jolla, California. This is contribution No. 378 of the Allan Hancock Foundation.

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**PARAPERCIS DIPLOSPILUS (PISCES:  
MUGILOIDIDAE), A NEW SPECIES  
FROM THE PHILIPPINE ISLANDS**

Janet R. Gomon

*Abstract.*—*Parapercis diplospilus* n. sp., from the Visayan Sea between northern Negros and Masbate islands, is most similar to *Parapercis ommatura* Jordan and Snyder, 1902, from which it differs most notably in having two prominent spots on the caudal-fin base instead of one, 22 to 23 instead of 23 to 26 scale rows around the caudal peduncle, and 9 to 11 instead of 12 to 13 scale rows below the lateral line. It also differs in certain body proportions and in having the caudal fin truncate with its dorsalmost rays slightly prolonged rather than rounded as in *P. ommatura*.

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In 1978, the Smithsonian Institution's expedition to the Philippine Islands collected 21 specimens of an undescribed species of *Parapercis*. This species is herein described and compared with *P. ommatura*, to which it is most similar. *P. ommatura* is known from Japan, Korea, and China.

Cantwell (1964) last revised the Indo-Pacific *Parapercis*, in which he treated 26 species. Schultz (1968) added six more: four newly described, one he had described in 1966, and one described by Kamohara (1960). He failed to include *P. elongata* Fourmanoir (1965) and *P. guezei* Fourmanoir (1966).<sup>1</sup> Since that time, four additional Indo-Pacific species have been described: *P. dockinsi* McCosker (1971), *P. gushikeni* Yoshino (1975), *P. biordinis* Allen (1976), and *P. cephalus* Kotthaus (1977). Current work by G. Stroud and J. E. Randall is expected to change the status of some of these species and add new ones.

### Methods

Methods and terminology are those of Hubbs and Lagler (1958) except for the following as modified by Cantwell (1964): in the pectoral fin the unbranched, dorsalmost ray is indicated by a lower case Roman numeral and the branched rays by Arabic numerals; each dorsal- and anal-fin ray with a separate external base was counted as one; lateral-line scale counts

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<sup>1</sup> *Parapercis elongata* was first described in 1965 under the name *Parapercis* sp., although referred to as *P. elongata* in the text of the description and in the index. Fourmanoir re-described the species in 1967.

include all pored scales in the series; counts of scale rows above the lateral line were begun at the origin of the first segmented dorsal-fin ray; scale counts below the lateral line were made along an oblique row from the anterior margin of the anus dorsoposteriorly to the lateral line. Vertebral counts, not including the urostylar vertebra, and median-fin ray counts were taken from radiographs. Fleishy orbit diameter is a horizontal measurement. Measurements (to the nearest 0.1 mm) were made with needlepoint dial calipers or with an ocular micrometer.

Type material has been deposited in the following collections: British Museum (Natural History), London (BMNH); Australian Museum, Sydney (AMS); Bernice P. Bishop Museum, Honolulu (BPBM); California Academy of Sciences, San Francisco (CAS); National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

*Parapercis diplospilus*, new species

Figs. 1, 2

*Holotype*.—USNM 220470 (75.0 mm SL), Philippine Islands, Visayan Sea between northern Negros and Masbate islands, southeast of Sicogon Island, 11°22'00"N, 123°19'48"E, 38.4 meters, 9 June 1978, Smithsonian Philippines Expedition 1978, sta. T-29, L. Knapp and party.

*Paratypes*.—All collected by the Smithsonian Philippines Expedition 1978, L. Knapp and party, in the Visayan Sea between northern Negros and Masbate islands. BPBM 22770 (3, 56.6–78.0), AMS I.21362-001 (3, 64.0–76.9), BMNH 1979.11.2.1–3 (3, 56.9–73.4), CAS 44715 (3, 61.7–70.1), all same data as holotype; USNM 220406 (1, 56.5), southeast of South Gigante Island, 11°30'23"N, 123°23'45"E, 38.4 meters, 8 June 1978, sta. T-27; USNM 220407 (1, 48.7), east of South Gigante Island, 11°31'38"N, 123°31'00"E, 38.4 meters, 8 June 1978, sta. T-26; USNM 220409 (6, 51.6–66.6), east of Sicogon Island, 11°27'45"N, 123°23'45"E, 47.6 meters, 4 June 1978, sta. T-3.

*Diagnosis*.—A species of *Parapercis* with: palatine teeth absent; usually 7 or 8 teeth in outer row of lower jaw; dorsal-fin rays V,22 (rarely VI,22); fourth dorsal-fin spine longest (fifth in a specimen with six spines), 6.4–7.8% SL; last dorsal-fin spine connected by membrane to base of first dorsal-fin ray (Fig. 2); anal-fin rays I,18; pectoral-fin rays i,13–i,15; scales below lateral line 9–11; scale rows around caudal peduncle 22–23; two prominent dark spots on caudal base, the upper one appearing ocellated in most specimens, the lower of equal size or slightly longer, but not ocellated.

*Description*.—Meristic values for the holotype are indicated by asterisks with the number of specimens having a given value placed in parentheses; morphometric values are expressed as percentages of SL, with values for the holotype given in parentheses after the ranges. The range of SL is 48.7 to 78.0 mm.



Fig. 1. *Parapercis diplospilus* n. sp., holotype, USNM 220470, 75.0 mm SL.

Dorsal fin V,22\*(20) or VI,22(1); anal fin I,18; principal caudal rays 8 + 7; pectoral fin i,13\*(7), i,14(13) or i,15(1); pelvic fin I,5; vertebrae 10 + 19\*(19) or 10 + 18(1) (one additional specimen abnormal with some vertebrae fused); gill rakers 8(3), 9\*(5), 10(10), 11(2) or 12(1); lateral-line scales 58(3), 59\*(8) or 60(6); scales above lateral line 3(1) or 4\*(16); scales below lateral line 9–11\*; scale rows around caudal peduncle 22–23\*.

Body elongate, greatest depth, at about level of anal opening, 14.5–17.6 (17.1); least depth of caudal peduncle 7.7–8.5 (7.9); tip of lower jaw to anal origin 39.6–43.5 (41.7). Head length 26.4–28.7 (26.4); snout length to fleshy orbit 6.5–7.1 (6.5); fleshy orbit diameter 6.0–7.9 (6.0); least fleshy interorbital width 2.2–2.5 (2.5); mouth oblique, lower jaw projecting beyond upper; maxilla reaching slightly posterior to a vertical through anterior edge of orbit; snout tip to rear edge of maxilla 7.2–9.1 (8.4); preopercle with 1–12 small spines on margin of angular portion; posterior margin of operculum with 1 strong spine at upper angle, not covered by skin posteriorly, and 11–21 small spines along ventral margin. Dorsal-fin base 62.0–68.0 (65.2); dorsal-fin spines increasing in length to fourth spine, fourth spine 6.4–7.8 (6.4), length of fifth spine about equal to third; dorsal-fin rays longer than spines; anal-fin base 45.3–49.9 (49.2); anal-fin origin approximately below fifth segmented dorsal-fin ray; posterior anal-fin base below posterior base of dorsal fin, appressed tips of posterior rays of both fins reaching almost to caudal-fin base; caudal fin truncate, uppermost rays slightly prolonged; pectoral fin acutely rounded, length 17.3–20.0 (18.8), reaching to or slightly posterior to vertical through anal-fin origin; pelvic fin pointed, fourth ray longest, reaching vertical through anus or between anus and anal-fin origin, fin length 19.9–23.6 (19.9).

Based on a Student's *t* test for allometry at the 95% level of significance, fleshy orbit diameter and length of fourth dorsal spine are negatively allometric. Greatest body depth is positively allometric. The remaining morphometric characters are isometric.

Teeth in 2 series on both jaws. Outer series of upper jaw a single row of

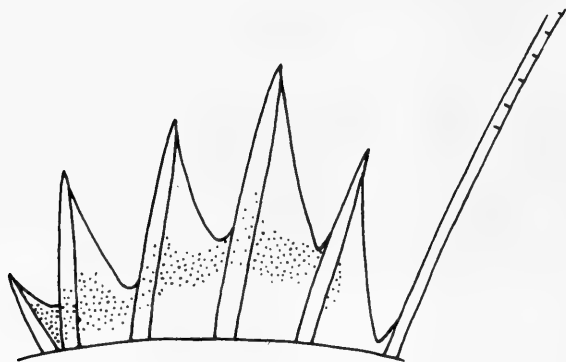


Fig. 2. Semidiagrammatic drawing of dorsal-fin spine arrangement of *Parapercis diplospilus*.

large, curved, conical teeth decreasing in size posteriorly; inner series a band of dense villiform teeth with depth of band decreasing posteriorly. Usually 8 (6–11) large, curved, conical teeth in outer row of lower jaw; inner series a band of villiform teeth mesially and a single row of small conical teeth laterally. Palatine teeth absent. Vomer with a chevron-shaped patch of small conical teeth in 2 to 3 rows.

Scales ctenoid; small scales extending onto basal half of caudal fin and basal sixth of pectoral fin in some specimens; snout, interorbital space, and occiput naked.

*Color in preservation.*—Background color of body and head yellowish to tan; free edges of body scales and scale pockets above lateral line with dark brown melanophores giving a tessellated, overall dark appearance to upper half of body; six or seven indistinct V-shaped markings of a darker brown also on upper half of body, relatively evenly spaced between head and caudal base, the more anterior markings extending slightly below lateral line; ventral half of body paler, with a row of eight dark-brown spots alternating small and large in size, in some specimens these spots extending ventrad to anal fin as faint vertical or oblique bars; a row of smaller, paler, and less distinct spots slightly above larger spots and just below lateral line; faint vertical bar extending from axilla to ventral body midline in some specimens; anal opening with U-shaped ring of dense, dark brown melanophores. Scaled portion of dorsal head surface with same tessellated appearance as upper body; cheek and operculum with 2 to 3 irregular dark-brown blotches; upper naked areas of head with small brown spots; lips and chin with scattered dark-brown melanophores, upper lip darkest mesially; lower surface of head, branchiostegal membranes, and isthmus without melanophores. Spinous dorsal fin with large, diffuse, dark spots on membranes

forming a band between first and fifth spines, membranes between first and third spines almost entirely covered with melanophores; soft dorsal fin with 2 to 3 rows of elongate, dark spots on membranes; anal fin with dark melanophores on anterior halves of membranes between consecutive rays, posterior portions of membranes without melanophores; caudal-fin base with two prominent, dark spots, each approximately pupil size, the upper spot appearing ocellated in some specimens, the lower spot often slightly more elongate and non-ocellate; very faint, irregular, narrow, dark bars posterior to prominent, dark spots; tips of mesial caudal-fin rays in some specimens, and all caudal-fin ray tips in others, dark brown; pectoral fin with scattered large, dark, melanophores at distal margin, fin base with an oblique dark bar; pelvic fin dark except for spine and distal margin.

**Reproduction.**—Hermaphroditism in mugiloidids was first suggested by Marshall (1950). He believed *P. hexophthalma* and *P. polyophthalma* to be males and females, respectively, of the same species, with males invariably being larger than females. One specimen intermediate in color pattern between the *hexophthalma* and *polyophthalma* forms appeared to have both ovarian and testicular tissue. G. Stroud (in litt.) has confirmed this suggestion of protogynous hermaphroditism, and along with J. E. Randall (in litt.) indicated that other species of *Parapercis* also reverse sex.

Gross examination of the gonads of the 21 type specimens (48.7–78.0 mm SL) of *P. diplospilus* showed all to have well developed ova. Examination of serial histological sections from the gonad of a 78 mm specimen (the only specimen sectioned) revealed the presence of both ovarian and testicular tissue with spermatids. Although examination of a series of specimens is needed for final determination of sexual mode, it is possible that *P. diplospilus* represents another example of protogynous hermaphroditism in *Parapercis*.

**Distribution.**—Known only from the type specimens collected by trawl in the Visayan Sea, Philippine Islands, at 38.4 to 47.6 meters depth. Scuba and rotenone collecting efforts to the south (Mindanao Sea and Tonon Strait) and to the east (Cuyo Islands) of the Visayan Sea failed to take this species.

**Etymology.**—The specific name is a noun in apposition taken from the Greek *diplo*, double, and *spilos*, spot, in reference to the two prominent caudal-fin spots.

**Comparisons.**—*Parapercis diplospilus* keys to *P. ommatura* Jordan and Snyder (1902), in Kamohara's (1960) review of Japanese parapercids, in Cantwell's (1964) revision of the genus, and in Schultz's (1968) review containing an expanded, modified key. Diagnostic characters shared by these two species are: dentition, as described above; spinous dorsal fin with middle rays longest, last spine connected by membrane to base of first segmented dorsal-fin ray (Fig. 2); caudal vertebrae 19; dorsal fin V,22; anal fin i,18 (rarely i,19 in *P. ommatura*); pectoral fin i,13 or i,14 (rarely i,15); dark,



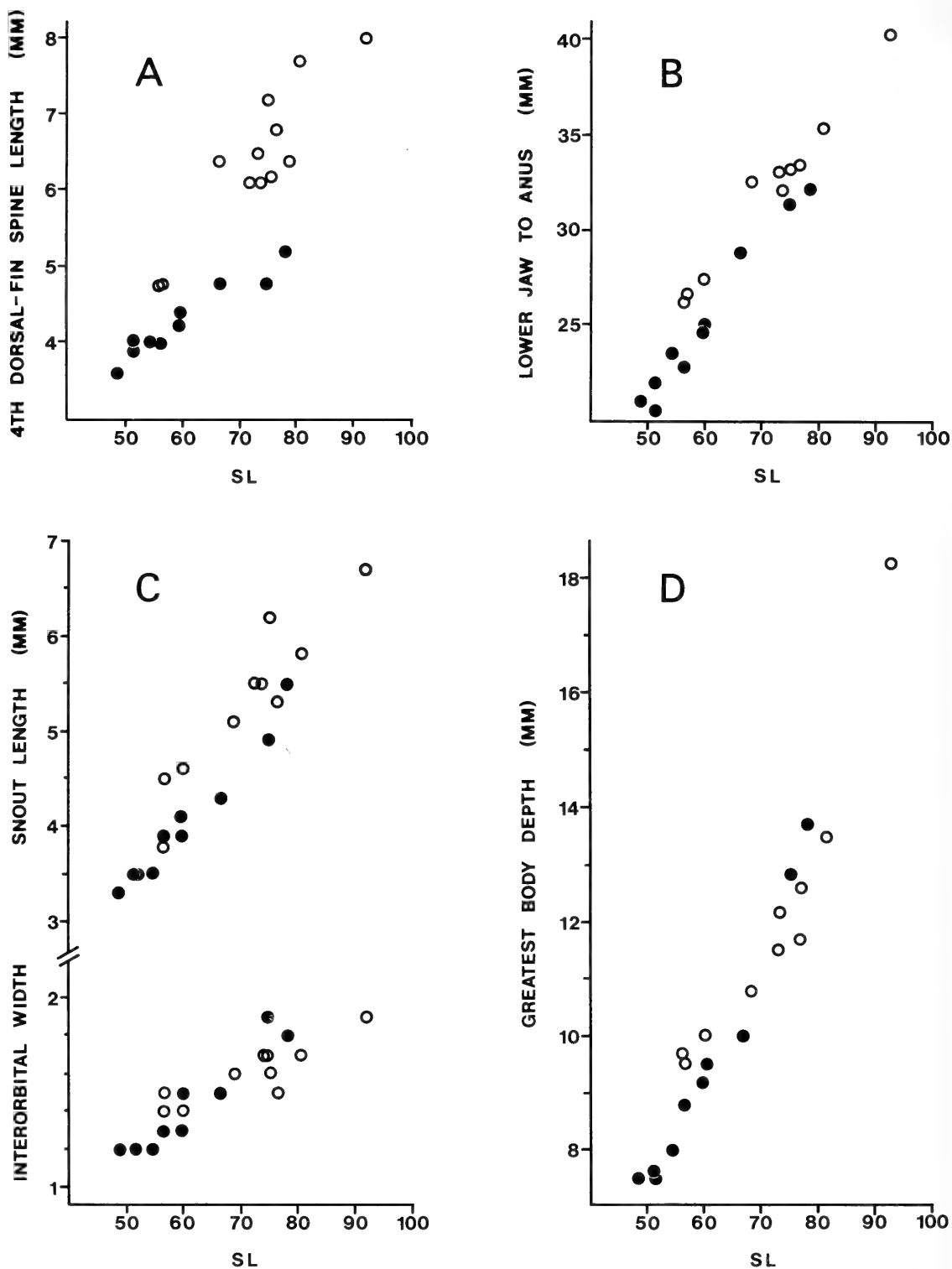


Fig. 3. Relationship between standard length and (A) 4th dorsal-fin spine length, (B) length from tip of lower jaw to anus, (C) snout length and fleshy interorbital width, (D) greatest body depth, in *Parapercis diplospilus* (closed circles) and *P. ommatura* Jordan and Snyder (open circles).

ocellate spot at upper caudal-fin base, and 2 to 3 rows of elongate spots on membrane between segmented dorsal rays. *Parapercis diplospilus* and *P. ommatura* also have similar lateral-line scale counts (58–60 in *P. diplospilus*, 58–61 in *P. ommatura*), number of scales above lateral line (usually 4), and gill-raker counts (8–12 in *P. diplospilus*, 9–13 in *P. ommatura*).

The following characters serve to distinguish *P. diplospilus* from *P. ommatura*: prominent dark spot on lower caudal-fin base (absent in *P. ommatura*); blotches on cheek (versus 2 stripes); 11–21 small spines along posteroventral edge of operculum (versus 1–18, usually 1–11, though spines may be worn down); scale rows around caudal peduncle 22–23 (versus 23–26); scales below lateral line 9–11 (versus 12–13); caudal fin truncate, upper rays slightly longer (versus broadly rounded). In body proportions, *P. diplospilus* has a lower spinous dorsal fin, fourth dorsal-fin spine length 6.4–7.8% SL (versus 8.1–9.6%; Fig. 3A), shorter length from tip of lower jaw to anus (39.6–43.5% versus 43.5–47.5%; Fig. 3B), and shorter snout length (6.5–7.1% versus 6.4–8.2%; Fig. 3C, upper). Greatest body depth and least fleshy interorbital width are smaller in *P. diplospilus* than in *P. ommatura* at small sizes, but *P. ommatura* is more slender with a narrow interorbital space at larger sizes (Fig. 3D and C, lower). Analysis of covariance of the linear regressions using the BMD10V program indicates significant or highly significant differences between the two species in all except greatest body depth, in which the regressions are curvilinear.

### Comparative Material

*Parapercis ommatura*.—JAPAN: Nagasaki, USNM 179803 (5, 56.6–75.3 mm, paratypes), USNM 50260 (3, 61.1–79.0, paratypes); Tsuruga, USNM 50258 (3, 73.2–92.7); Toba Mkt., USNM 151813 (2, 72.9–76.6); Tokyo, USNM 50261 (2, 75.7–89.0). KOREA: USNM 37776 (2, 75.6–79.0). CHINA: USNM 6867 (3, specimens damaged).

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## THE SOUTH AMERICAN FISH GENUS *RACHOVISCUS*, WITH A DESCRIPTION OF A NEW SPECIES (TELEOSTEI: CHARACIDAE)

Stanley H. Weitzman and Carlos Alberto Gonçalves da Cruz

*Abstract.*—*Rachoviscus graciliceps*, a new species of characid fish, is described from small coastal blackwater streams near Prado, Bahia, Brazil. The relationships of this species appear close to *Rachoviscus crassiceps* Myers (1926) which is redescribed on the basis of the types and new specimens from small blackwater streams near the Atlantic coast 50 to 60 km south of Paranaguá, Paraná, Brazil. The new species, *R. graciliceps* appears to be less derived than *R. crassiceps*. The type locality of *R. crassiceps*, the neighborhood of Rio de Janeiro, is discussed and found to be questionable. *Rachoviscus* is redefined; its relationships to other characids remain obscure.

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*Rachoviscus* Myers (1926) was established for two aquarium specimens of a new species, *Rachoviscus crassiceps* Myers (1926), sent to Myers by Arthur Rachow of Germany. The specimens were said to have been imported from the neighborhood of Rio de Janeiro but no specimens with verified locality information have ever been recorded. All the later aquarium reports cited below seem to be based on the account of Rachow in Holly Meinken, and Rachow (1939). The species remained known only from the specimens examined by Myers and from Rachow's account until September of 1975 when Persio de Santos Filho, a student at the Universidade de São Paulo, collected specimens about 50 km south of Paranaguá, Paraná, Brazil in small blackwater streams and ponds emptying into the Atlantic Ocean. In December of that same year, two small specimens of *Rachoviscus crassiceps* were obtained by N. Menezes and W. L. Fink from a small blackwater stream near the Atlantic Ocean not far from the locality visited by de Santos Filho. In spite of attempts to collect additional specimens, none was found. At that time many of the coastal blackwater streams and ponds were dry, including those visited by de Santos Filho. The two specimens, a pair, were brought alive to Washington, D.C. where they grew to adults but never spawned. Both were preserved after surviving three and one half years in aquaria and are now USNM 220732.

The new species, *Rachoviscus graciliceps*, was collected by Carlos Cruz in October 1977 from a small blackwater stream near the Atlantic Ocean about one km north of the town of Prado in Bahia, Brazil. Live specimens of this species were brought to Rio de Janeiro where they spawned in aquaria.

The coastal blackwater streams of eastern Brazil have been little collected and the distributions here reported for these two species may be greatly extended in the future.

The methods used here for counting and measuring specimens were those described for characoids by Fink and Weitzman (1974). All morphometric values in the descriptions are expressed as a percentage of standard length (SL) except where otherwise designated. The value for the holotype or lectotype is given first followed by values for the remaining males in parentheses ( ) and for the females in brackets [ ]. In some cases of meristic values, only a series of figures, in parentheses, is given after the holotype; these include counts for both males and females. Specimens have been deposited in the following museums: California Academy of Sciences (CAS) (note, SU following CAS means the number is a former Stanford University Natural History Museum number with the specimen now deposited at CAS), Museu de Zoologia da Universidade de São Paulo (MZUSP), Museu Nacional do Rio de Janeiro (MN), and the National Museum of Natural History, Smithsonian Institution (USNM).

#### *Rachoviscus* Myers

*Rachoviscus* Myers, 1926:1, original description, type by monotypy *Rachoviscus crassiceps* Myers 1926.

*Diagnosis.*—The following series of characters will distinguish *Rachoviscus* from all other genera of the Characidae: pelvic fins i,5 with only second and third branched rays of males bearing bony hooks or spines on ventral surface of fin; one bony spine to each ray segment that bears a spine.

#### *Rachoviscus* Myers

*Rachoviscus* Myers, 1926:1, original description, type by monotypy *Rachoviscus crassiceps* Myers 1926.

*Diagnosis.*—The following series of characters will distinguish *Rachoviscus* from all other genera of the Characidae: pelvic fins i,5 with only second and third branched rays of males bearing bony hooks or spines on ventral surface of fin; one bony spine to each ray segment that bears a spine. Other important characters for *Rachoviscus* are as follows. Premaxillary teeth in two rows, teeth of outer row one or two, unicuspid or tricuspid. Those of inner row five to six and mostly tricuspid, some bicuspid or unicuspid. Teeth of these two rows sometimes closely approximate, and giving appearance of a single undulating row of teeth. Lateral line incomplete, of about four to five perforated scales placed anteriorly. Maxillary bone set with teeth for about one-third to two-thirds of its length. These teeth unicuspid or anterior first to third teeth may be tricuspid, others unicuspid. Sub- and postorbital

area nearly completely covered by four infraorbital bones. Third infraorbital (=great or second suborbital of Eigenmann) with its ventral border in contact with preopercle. In life both known species have bright red adipose fins in both sexes and the distal one-quarter to one-third of anal fin pigmented with a stripe of red or yellow, especially in males.

*Discussion.*—The relationships of this genus to other characid genera are obscure. Myers (1926) originally placed it in the nominal subfamily Cheirodontinae because he believed the type species had a single row of premaxillary teeth. Myers further suggested the relationships might be with *Prionobrama* Fowler.

Géry (1977:347) placed *Prionobrama*, *Rachoviscus*, *Paragoniates* Steindachner, *Leptagoniates* Boulenger, *Xenagoniates* Myers, and *Phenagoniates* Eigenmann and Wilson in a group because they are reported to have a “very compressed, usually elongate body with a long anal fin.” He further stated that “they usually have a single series of teeth on the upper jaw.” Géry placed *Paragoniates*, *Rachoviscus*, and *Prionobrama* in a single group in his key because they share the following characters: the presence of an adipose fin, a relatively short body (compared to the other genera in his Paragoniatae), an incomplete lateral line and less than 50 anal-fin rays. He associated the genera *Prionobrama* and *Rachoviscus* in his key by their common possession of 29 to 37 anal-fin rays, 10 to 16 maxillary teeth, and 35 to 41 scales. Géry was uncertain about this placement and remarked that both of these genera could be placed in the Aphyocharacinae.

The problem of the putative relationships among these six genera needs much study and will be considered here only as it may concern the relationships of *Rachoviscus*. The important questions that must be considered here are as follows. What are the unique characters shared by the species of *Rachoviscus* that can be used to define the genus and phylogenetically relate the species? The same question must be asked for *Prionobrama* and *Paragoniates*. Finally are there any shared derived characters that might indicate a relationship between *Rachoviscus* and *Prionobrama*, or between *Rachoviscus* and *Paragoniates*?

The characters utilized by Géry (1977:347) are difficult to evaluate from a phylogenetic point of view. One character utilized by Géry, the possession of an adipose fin, can be eliminated for phylogenetic analysis because it is almost undoubtedly primitive for the family. Outgroup comparison of the Characidae with other characoids and the Otophysi as a whole shows that this character is not unique to the Characidae. The character probably occurred in the family's ancestor and therefore its presence cannot be used to relate genera or species in monophyletic lines within the family. The loss of the adipose fin appears to have occurred independently several times within the family making its absence difficult to use in phylogenetic analysis.

The other characters as listed by Géry (1977) occur commonly in diverse

groups of characids. Some of these characters, such as the reduced lateral-line count and a single row of premaxillary teeth, are "simple" loss characters which may have evolved independently and repetitively in characids. Attention to morphological detail of jaw modification and tooth arrangement may, in some cases at least, make a reduction in tooth rows useful in phylogenetic analysis. Other characters used by Géry are apparently genetically labile characters such as fin-ray counts and tooth counts, or body shape. The primitive versus derived nature of these kinds of characters is very difficult and perhaps often impossible to evaluate since the advanced versus plesiomorphic polarities of similar appearing characters may or may not be the same in these instances of labile characters. Therefore, these characters are often useless for phylogenetic analysis except in certain specific cases wherein a large series of such characters may correlate in their distributions among a series of taxa when processed by outgroup comparison and parsimony.

The species of *Rachoviscus* seem related by the unique pelvic-fin structure and color pattern described above in the generic description. The two species of *Prionobrama*, *P. filigera* Cope and *P. paraguayensis* Eigenmann, seem related to each other by a large series of characters none of which is unique to these two species but which occur nowhere else in this particular combination, producing a series of correlated synapomorphies that undoubtedly has real phylogenetic significance. They have large, white-tipped anterior anal-fin lobes and elongate strong pectoral fins with large pectoral-fin muscles and pectoral girdle. The dorsal-fin origin and anal-fin origin are nearly approximate or the dorsal-fin origin is a little anterior to the anal-fin origin. They have an elongate, compressed body with an elongate anal fin of 29–37 branched anal-fin rays, a nearly fully toothed maxillary bone with mostly unicuspid teeth, a single series of tricuspid teeth on the premaxillary bone, an incomplete lateral line and an oblique mouth upturned distally. A few of these derived characters were used by Myers (1926) to relate *Prionobrama* and *Rachoviscus*. They were stated to share a distally upturned mouth, a well toothed maxillary, an incomplete lateral line, and a single row of premaxillary teeth. New information shows that *Rachoviscus* has two rows of premaxillary teeth and that a well toothed maxillary occurs only in one species, *R. crassiceps*, the most derived. We believe than many more than the two remaining shared characters, a distally upturned mouth and an incomplete lateral line, are needed if *Prionobrama* and *Rachoviscus* are to be considered close relatives. This is especially convincing since both of these characters occur commonly in characoids of no apparently close phylogenetic relationship to either of these genera. We fail to find unique synapomorphic characters uniting *Rachoviscus* and *Prionobrama* more closely to each other than to any other characids.

The problem of a possible relationship of *Rachoviscus* with *Paragoniates*



Fig. 1. Localities reported for *Rachoviscus graciliceps* and *Rachoviscus crassiceps*. **Black disk within two circles**, type locality of *R. graciliceps*, Prado, Bahia. **Black star**, putative type locality for *R. crassiceps*, neighborhood of Rio de Janeiro; see text. **Black star within two circles**, new records for *R. crassiceps*, near Guarituba and Brejotuba, Paraná. All localities are in Brazil.



is more complex but involves much the same kinds of considerations. *Paragoniates* is a very compressed deep-bodied, rather elongate fish with a long anal fin of about 34–48 rays, according to Géry (1977). It has a combination of a distally upturned mouth and long slender jaw bones of a shape found nowhere else in characoids. This is associated with the two tooth rows of the premaxillary in at least some populations of *Paragoniates* being compressed together, producing an appearance somewhat similar to that of the premaxillary tooth rows in *Rachoviscus crassiceps*. The premaxillary tooth rows of *Paragoniates* were reported as one row by Eigenmann (1915), but two specimens of *Paragoniates* sp. from the Rio Tiznados, Guarico, Venezuela (MBUCV-V-7108), have one or two teeth in an outer row which are more or less pressed against the inner main row, giving the impression of a single undulating row. Six specimens of *Paragoniates alburnus* Steindachner from the Rio Pachitea at Porto Inca, Peru (FMNH 83874) appear to have a short inner row of two teeth instead of an outer row of two teeth. The main row of teeth is present as a continuous outer row. *Paragoniates* has a short lateral line of 13–16 perforated scales in the specimens recorded above. The dorsal fin originates well posterior to the origin of the anal fin and the pectoral fins are elongate, with enlarged pectoral-fin muscles and girdles. *Paragoniates* has a deep, short caudal peduncle relative to most characid species in genera that are presumably relatively primitive such as *Brycon* Müller and Troschel, *Astyanax* Baird and Girard, and *Moenkhausia* Eigenmann. The Venezuelan specimens of *Paragoniates* reported above have the pelvic-fin rays i,6 whereas the Peruvian population sample had i,7, the usual count for characids, including the primitive genera in the family.

Of the apomorphic characters recorded above for *Paragoniates*, *Rachoviscus* has a relatively deep caudal peduncle (especially in the more derived species, indicating an origin independent from that of *Paragoniates*), a reduced lateral line, and a distally upturned mouth. All these characters occur commonly elsewhere in the Characidae and probably represent independent derivations for these two genera. The trend toward a reduction in pelvic-fin rays in *Paragoniates* is undoubtedly independent of the reduction in *Rachoviscus*, and although both genera appear to have a trend toward compression of premaxillary tooth rows, in detail the premaxillary bones are very different. Furthermore, it is only the more derived species of *Rachoviscus* that has this character.

Géry (1977:347) suggests that *Rachoviscus* might be allied to *Aphyocharax* Günther, but discussed no evidence for this opinion. Although all species of *Aphyocharax* appear to have their premaxillary teeth in a single row, there is much morphological divergence in the jaws of these fishes (Eigenmann, 1915). We could find no synapomorphic character between species of *Aphyocharax* and *Rachoviscus*. Eigenmann's definition of *Aphyocharax* is extensive, but most of the characters listed are either primitive for the

Characidae or, when derived, are found in a number of apparently more or less remotely related, diverse characid genera. An examination was made of the pelvic fins of eight morphologically diverse species of *Aphyocharax* from localities in Paraguay, Argentina, Brazil, Bolivia and Venezuela. These specimens (USNM numbers 220869, 220870, 220871, 220872, 220873, 220874, 220875 and 220878) are unidentified because no recent and adequate study of the species and their relationships is available. In all those species that had no pelvic-fin spines, the males had an i,7 pelvic-fin ray count. Of those that had i,7 or i,6 pelvic-fin rays, some males had spines on all the fin rays except the anterior undivided ray (one species), spines on all soft rays (one species), on all soft rays except the last, or on the first, second, third and fourth soft rays but not on the three terminal soft rays. All specimens that had spines in the pelvic fin had the spines extending ventrally. The pelvic fins of the species of *Aphyocharax* examined are not remarkably different from those found in many other characids and do not show any synapomorphies with *Rachoviscus*. A more complete evaluation of the possible relationship of *Aphyocharax* and *Rachoviscus* must await a detailed phylogenetic study of the species of *Aphyocharax*.

This discussion indicates that the relationships of *Rachoviscus* within the Characidae remain unknown. This genus was placed with the "cheirodontin" characids by Myers (1926) following the traditional hypothesis established by Eigenmann (1915) that all small characoids with a single row of premaxillary teeth are phylogenetically related in a single characid subfamily, the Cheirodontinae. The phylogenetic unity of the Cheirodontinae was challenged by Fink and Weitzman (1974). In the present study, *Rachoviscus* was found to have two rows of premaxillary teeth, a fact which would place it in the characid subfamily Tetragonopterinae, following a traditional concept best expressed by Eigenmann (1917). The phylogenetic relationships among the tetragonopterine characids are essentially unknown and unstudied and the group is probably a paraphyletic assemblage or a series of paraphyletic assemblages with undetermined relationships.

*Rachoviscus graciliceps*, new species

Figs. 1-2

*Holotype*.—MZUSP 14387, SL 44.4 mm, Brazil, State of Bahia; taken from one of three small creeks about 1 km north of Prado and about 500 meters from Atlantic Ocean, 39°14'W, 17°19'S, 18 October 1977 by Carlos Alberto Gonçalves da Cruz.

*Paratypes*.—3, MZUSP 14388, 14389, and 14390, SL 39.8–42.9 mm; 2, USNM 220355, 40.3–47.6 mm; both lots with same data as holotype. 1 additional specimen, USNM 220355, SL 35.1 mm, is young of specimens collected with holotype. 2, MN 10585 and 10586, SL 33.2–37.2 mm, col-

lected at same locality as holotype, 1–4 December 1978 by E. Izecksohn, O. L. Peixoto and C. A. G. da Cruz.

*Diagnosis.*—This species differs markedly from *R. crassiceps* in shape of head and caudal peduncle, configuration of premaxillary and maxillary teeth as well as in number of scale rows around caudal peduncle and predorsal scale count. *Rachoviscus graciliceps* has a more slender head, interorbital width quite variable but 29.1–35.0% of head length ( $n = 5$ ); *R. crassiceps* has an interorbital width 37.5–43.8% of head length ( $n = 12$ ). The caudal peduncle of *R. graciliceps* is much more slender than that of *R. crassiceps*. Caudal peduncle length of *R. graciliceps* nearly same as caudal depth length, 93.0–100% of caudal peduncle depth; In *R. crassiceps*, caudal peduncle length is 62.7–74.1% of caudal peduncle depth. *Rachoviscus graciliceps* has 14 scale rows around caudal peduncle; *R. crassiceps* has 18. Predorsal scale count in *R. graciliceps* ( $n = 5$ ) 14 to 16,  $\bar{x} = 15$ ,  $SD = 0.707$ , and in *R. crassiceps* ( $n = 11$ ) 17 to 19,  $\bar{x} = 18.2$ ,  $SD = 0.751$ . Lateral series scale counts not significantly different; when tested with a two-tailed Student's *t* test using square root transformations to compute value of *t*,  $t = 1.88$  and  $P = 0.04$ . In *R. graciliceps* ( $n = 5$ ), always 35 scales in a lateral series and *R. crassiceps* ( $n = 11$ ) 34–39 scales,  $\bar{x} = 36.5$ ,  $SD = 1.695$ .

Premaxillary tooth rows of *R. crassiceps* “compressed” together (see description below) but remain separate in *R. graciliceps* as in most other characids with 2 premaxillary tooth rows. *Rachoviscus graciliceps* with fewer teeth (3–8) on maxillary, occurring on about anterior one-fourth to one-third of its length, whereas more (8–14) teeth occur along about one-half to two-thirds of that length in *R. crassiceps*.

*Description.*—Morphometric values based on 2 males and 3 females unless otherwise designated. Specimens spawned and raised in aquaria were not utilized in taking morphometric or meristic values. Eight specimens with locality data were in good enough condition for some of the meristic values. Body moderately compressed, relatively elongate, greatest depth most often at dorsal-fin origin, occasionally anterior to that origin. Greatest depth 35.5 (32.4–35.5,  $\bar{x} = 34.0$ ) [32.0–35.2,  $\bar{x} = 33.7$ ]. Depth at dorsal-fin origin same as greatest depth in males, in females [31.7–34.0,  $\bar{x} = 32.6$ ]. Predorsal body profile slightly convex, slightly concave over nape, continuing anteriorly to dorsal to eye. Snout slightly convex. Body profile along base of dorsal fin slightly convex, nearly straight between posterior dorsal-fin termination and adipose fin. Posterior to adipose fin, body profile slightly convex up to origin of anterior procurent rays of dorsal lobe of caudal fin. Dorsal-fin origin about equidistant between snout tip and caudal-fin base or slightly nearer to the latter. Distance between snout tip and dorsal-fin origin 54.1 (53.2–54.1,  $\bar{x} = 53.7$ ) [52.6–53.8,  $\bar{x} = 53.3$ ]. Distance between dorsal-fin origin and caudal-fin base 50.9 (50.9–51.3,  $\bar{x} = 51.1$ ) [49.7–50.4,  $\bar{x} = 50.2$ ]. Distance

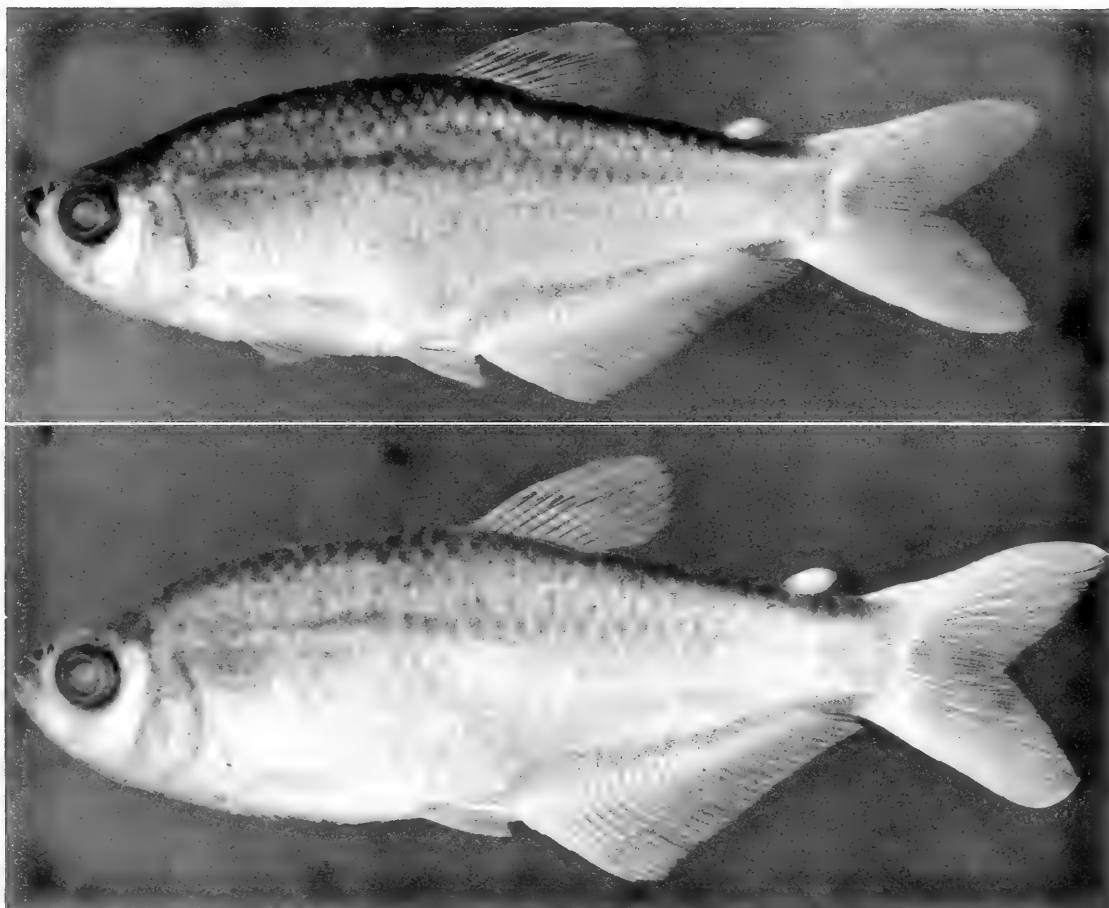


Fig. 2. **Above:** *Rachoviscus graciliceps*, new species, MZUSP 14387, SL 44.4 mm, holotype, male. **Below:** *Rachoviscus graciliceps*, MZUSP 14389, SL 42.9 mm, paratype, female. Both specimens from 1 of 3 small blackwater streams about one km north of Prado, Bahia, Brazil, 18 October 1977.

between posterior border of eye and dorsal-fin origin as a percentage of distance between dorsal-fin origin and caudal-fin base 89.7 (82.0–89.7,  $\bar{x}$  = 85.9) [83.4–85.4,  $\bar{x}$  = 84.2]. Ventral body profile moderately convex from symphysis of lower jaw to posterior termination of anal-fin base. Distance between snout tip and pectoral-fin origin 27.7 (26.9–27.7,  $\bar{x}$  = 27.3) [26.3–26.6,  $\bar{x}$  = 26.5]. Distance between snout tip and pelvic-fin origin 49.5 (48.5–49.5,  $\bar{x}$  = 49.0) [48.7–50.5,  $\bar{x}$  = 49.4]. Distance between snout tip and anal-fin origin 59.9 (57.1–59.9,  $\bar{x}$  = 58.5) [56.3–63.8,  $\bar{x}$  = 60.2]. Caudal peduncle depth 14.2 (12.6–14.2,  $\bar{x}$  = 13.4) [12.3–13.3,  $\bar{x}$  = 12.9]. Caudal peduncle length 13.5 (12.6–13.5,  $\bar{x}$  = 13.1) [12.3–13.2,  $\bar{x}$  = 12.6].

Head deep, relatively short, bony head length 25.0 (23.9–25.0,  $\bar{x}$  = 24.5) [23.3–25.9,  $\bar{x}$  = 24.6]. Snout moderately acute, not blunt, lower jaw protruding slightly beyond upper jaw. Mouth gape angled ventrally. Posterior ventral border of maxillary bone reaching to or somewhat beyond a vertical

line drawn ventrally from anterior border of pupil of eye. Horizontal eye diameter 31.5% (31.5–32.5,  $\bar{x}$  = 32.0) [28.2–34.0,  $\bar{x}$  = 30.8] of bony head length. Snouth length 26.1% (26.1–27.2,  $\bar{x}$  = 26.7) [21.4–27.0,  $\bar{x}$  = 24.6] of bony head length. Least bony interorbital width 33.3% (30.7–33.3,  $\bar{x}$  = 32.0) [29.1–35.0,  $\bar{x}$  = 31.8] of bony head length.

Dorsal-fin rays ii,9 in all specimens (last ray not split to its base). Dorsal-fin length (=dorsal-fin origin to distal tip of longest ray when fin adpressed to back) 25.0 (25.0–25.2,  $\bar{x}$  = 25.1) [23.1–25.6,  $\bar{x}$  = 24.0]. Distal margin of dorsal fin strongly convex in both sexes (Fig. 2).

Adipose fin present. Anal-fin rays iv,26 (iv,24–iv,25) [iv,23 in one and iv,24 in two]. Last anal-fin ray split to its base. Margin of anal fin slightly concave, nearly straight (Fig. 2). Pectoral-fin rays i,13 in all specimens. Posterior tip of longest ray not reaching pelvic-fin origin in either males or females.

Anal-fin spines of a male specimen, SL 47.6 mm, USNM 220355 as follows: second branched ray through twenty-fifth branched ray with spines, these about five in number for about anterior 12 fin rays, gradually diminishing in number to one spine at twenty-fifth anal-fin ray. One spine for each side of each ray segment in all cases. Spines in a continuous series with distal 5 or 6 ray segments free of spines. All spines extend laterally and curve somewhat dorsally. Females without anal-fin spines.

Caudal fin 10/9 in all specimens, its dorsal and ventral lobes equal in length. Caudal fin and dorsal fin without bony hooks.

Pelvic-fin rays i,5 in all specimens. Pelvic fin length 12.2 (12.2–12.6,  $\bar{x}$  = 12.4) [12.1–12.8,  $\bar{x}$  = 12.4]. Second branched pelvic-fin ray of a male specimen, SL 47.6 mm, USNM 220355, with 11 thick conical spines with their apices pointing medially. Third branched pelvic-fin ray of this specimen bears 8 similar spines. All these spines confined to ventral surface of fin. Females without pelvic-fin spines.

Scales cycloid. Lateral line incomplete, perforated lateral-line scales 5 (3 or 5 in males, 5 in all females). Scales in a lateral series 35 in all specimens. Scale rows between dorsal-fin origin and pelvic-fin origin 15 in all specimens. Predorsal scales 16 (14–16,  $\bar{x}$  = 15 in all specimens).

Premaxillary teeth in 2 very distinct rows, outer row teeth tricuspid and 1 to 2 in number, not placed far back and pressed against or between inner row teeth. Outer row teeth lie anterior to space between first and second, and second and third inner row teeth. Inner row teeth 5 in all specimens, all tricuspid. Medial tooth with a very small medial cusp. Maxillary bone with 3–8 teeth along approximately anterior one-fourth to one-third of its total length. Anterior 1 to 3 teeth tricuspid, others unicuspid. Dentary with a single row of teeth. Anterior 5 teeth large and tricuspid; posterior 5 to 9 teeth unicuspid and small. Small specimens with fewer dentary teeth than large specimens.

Total vertebrae including Weberian apparatus and terminal complex centrum (35–36,  $\bar{x}$  = 35.4,  $n$  = 8). Gill rakers 7/10 in holotype, (6–7 on upper limb, 10–11 on lower limb, never more than a total of 17 or less than 16 rakers,  $\bar{x}$  = 16.6,  $n$  = 8).

*Color in alcohol*.—Body and head a pale brown, immaculate, shading to dark brown along dorsum and to white on belly. Cheeks and opercle pale brown. Top of head and snout dark brown. Color much like that of *R. crassiceps* except none of specimens at hand are nearly black or very dark brown. Fins hyaline except for dorsal and anal fins. Dorsal fin with a row of dark pigment spots between first or second through fourth or fifth fin rays. This pigment located in about mid-length of these rays and producing a horizontal dark line across fin (Fig. 2, above, MZUSP 14387). A similar line of dark pigment occurs along length of anal fin at about distal two-thirds of fin-ray length from base of fin.

*Color in life*.—This color description is taken from color slides of specimens kept in aquaria. Pigment distribution and colors very similar to those in *R. crassiceps*. Back olive brown with a considerable amount of yellow. Sides of body silver but with lemon yellow in abdominal area. Caudal peduncle and area dorsal to anal fin reflect a light pink silvery color. Caudal fin greenish lemon yellow, tips of lobes, especially ventral lobe, pale red, sometimes tipped white. Adipose fin deep red, especially in male. Dorsal fin white to greenish or reddish white, distal to dark streak or line across its middle length, hyaline ventral to that streak. Anal fin with distal one-quarter to one-third of its length a dusky red or sometimes yellow, especially in males. Basal portion of anal fin hyaline. Pelvic fins of males with a distal reddish or yellowish spot, otherwise hyaline. Pectoral fins hyaline.

*Sexual dimorphism*.—Sexual differences not as apparent in *R. graciliceps* as in *R. crassiceps*. Females a little paler in life colors than males, and red of adipose fins likely to be less extensive. Difference in caudal-peduncle depth noted below for males and females in *R. crassiceps* appears absent or at least not as obvious in *R. graciliceps*. Males have this depth 12.6 to 14.2,  $\bar{x}$  = 13.4% of standard length, females 12.3 to 13.3,  $\bar{x}$  = 12.9%. Only males have hooks on pelvic and anal fins.

*Etymology*.—From Latin *gracilia*, slender or thin, and *ceps*, head. The name is used in reference to the fact that this species has a more slender head than *R. crassiceps*.

*Rachoviscus crassiceps* Myers

Figs. 1, 3, 4

*Rachoviscus crassiceps* Myers, 1926:389, original description, figure, Brazil, neighborhood of Rio de Janeiro.—Rachow, 1928:18, aquarium description, figure.—Arnold and Ahl, 1936:115, aquarium description, figure.—





Fig. 3. *Rachoviscus crassiceps*, USNM 220732, SL 38.5 mm, male, small blackwater stream just south of Guarituba, Paraná, Brazil, 28 December 1975. Bent fin rays of caudal, dorsal, anal, and pectoral fins are due to regrowth from damage in an aquarium.

Rachow in Holly *et al.*, 1939:284, restatement of original description, aquarium description, figure, breeding habits in aquaria.—Sterba, 1959:120, aquarium description, figure.—Géry, 1977:350, rediscovery near Rio de Janeiro; reference actually to specimens (USNM 220732) recorded below from near Guarituba, Paraná, Brazil.

*Comments.*—This incomplete synonymy lists the major aquarium publications in which this fish has appeared. This fish has never been accorded systematic treatment subsequent to its original description. The species is little known to aquarists and to systematic ichthyologists. All of the above aquarium reports appear to have been taken from Myers (1926), Rachow (1928) and Rachow in Holly *et al.* (1939). The last reference contains a brief comment on its original importation as an aquarium fish into Germany. The stated type locality can be considered questionable. The fish was first imported by M. Gregor of Hamburg in 1926 from the “Umgebung von Rio de Janeiro.” At that time the German aquarium import trade was receiving fishes from coastal or near coastal cities in southern Brazil such as Rio de Janeiro, Santos, Paranaguá and Pôrto Alegre. There is no certain record of this species from anywhere except the two localities cited below, both within 10 kilometers of Guarituba, a small town about 50 km south of Paranaguá. Although this species may occur (or may have occurred) in small blackwater streams as far as or further north than Rio de Janeiro, there is no firm

evidence that the type locality is correct. The fish could have been imported from Paranaguá and transshipped to Rio de Janeiro before shipment to Germany.

*Material examined*.—Lectotype, USNM 92971, 32.7 mm SL, male, pelvic rays with hooks; lectotype here selected from two syntypes originally in collection of G. S. Myers, number 86. Second original syntype, 1, CAS(SU) 18146, 28.1 mm SL, same locality data as lectotype. USNM 220732, 2, SL 34.1 mm and 38.5 mm, Brazil, State of Paraná, small blackwater stream just south of Guarituba, about 25 to 50 meters from Atlantic Ocean, 24°37'W, 25°55'S, collected by N. Menezes and W. L. Fink, 28 December 1975. MZUSP 14635, 4, SL 21.8–30.5 mm, largest a male, others females, Brazil, State of Paraná, stream pond at beach of Brejotuba, 10 km south of Guarituba (24°37'W, 25°55'S), collected by Persio de Santos Filho, September 1975. USNM 220756, 2, SL 21.5–24.4 mm, females, same locality data as MZUSP 14635. USNM 220757, 2, SL 23.7 and 29.5 mm, both cleared and stained with alizarin, both with same locality data as MZUSP 14635.

*Diagnosis*.—See diagnosis above under *R. graciliceps*.

*Description*.—Morphometric values based on 4 males and 7 females unless otherwise designated. Body moderately compressed, relatively deep, greatest depth usually anterior to dorsal-fin origin 38.5 (36.7–40.0,  $\bar{x}$  = 38.6) [37.5–39.3,  $\bar{x}$  = 38.5]. Depth at dorsal-fin origin 37.0 (36.7–39.0,  $\bar{x}$  = 37.8) [35.8–38.5,  $\bar{x}$  = 37.1]. Predorsal body profile slightly convex, somewhat concave at nape and again convex over eye and snout. Base of dorsal fin and body profile from base of dorsal fin to origin of adipose fin origin nearly straight. Body profile posterior to adipose fin straight to origin of caudal fin at beginning of anterior procurent caudal-fin rays. Dorsal-fin origin nearer to caudal-fin base than to snout tip. Distance between snout tip and dorsal-fin origin 55.7 (55.1–58.7,  $\bar{x}$  = 56.3) [56.2–59.5,  $\bar{x}$  = 58.1]. Distance between dorsal-fin origin and caudal-fin base 49.2 (48.6–49.8,  $\bar{x}$  = 49.1) [45.4–50.8,  $\bar{x}$  = 47.6]. Distance between posterior border of eye and dorsal-fin origin as a percentage of distance between dorsal-fin origin and caudal-fin base 94.4 (93.3–97.3,  $\bar{x}$  = 95.1) [90.7–102.0,  $\bar{x}$  = 97.1]. Ventral body profile moderately convex from symphysis of lower jaw to anterior procurent fin ray of caudal fin. Distance between snout tip and pectoral-fin origin 32.4 (26.5–32.4,  $\bar{x}$  = 28.8) [26.6–28.4,  $\bar{x}$  = 27.8]. Distance between snout tip and pelvic-fin origin 51.7 (49.1–51.7,  $\bar{x}$  = 50.0) [49.2–53.5,  $\bar{x}$  = 50.9]. Distance between snout tip and anal-fin origin 62.1 (60.3–62.1,  $\bar{x}$  = 61.1) [59.8–65.1,  $\bar{x}$  = 62.4]. Caudal peduncle depth 16.5 (15.3–16.5,  $\bar{x}$  = 15.9) [13.5–15.0,  $\bar{x}$  = 14.2]. Caudal peduncle length 11.3 (9.9–11.3,  $\bar{x}$  = 10.7) [9.4–10.6,  $\bar{x}$  = 10.0].

Head deep, short; bony head length 24.2 (24.1–25.1,  $\bar{x}$  = 24.5) [23.5–28.4,  $\bar{x}$  = 25.5]. Snout blunt, lower jaw protruding beyond upper jaw. Mouth gape angled posteroventrally. Posterior ventral border of maxillary bone reaching to or somewhat beyond a vertical line drawn ventrally from anterior border



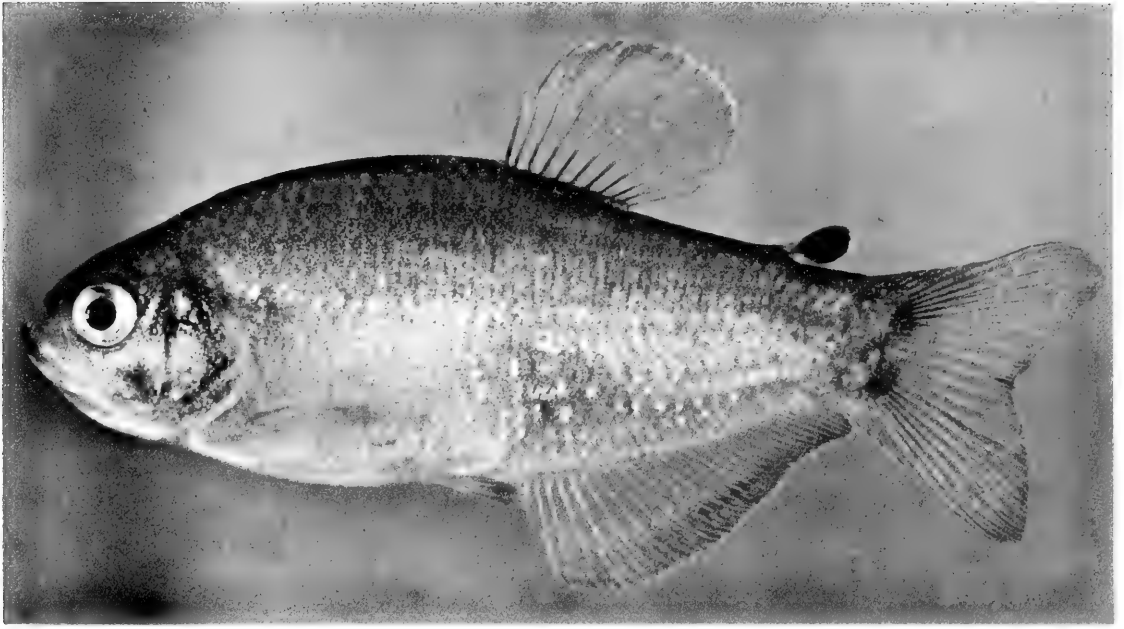


Fig. 4. *Rachoviscus crassiceps*, USNM 220732, SL uncertain at time of photograph, live adult male, same specimen as Fig. 3. Note black color of adipose fin, due to its deep red color in life.

of pupil of eye. Horizontal eye diameter 30.5% (30.5–33.3,  $\bar{x}$  = 32.0) [32.8–37.9,  $\bar{x}$  = 35.3] of bony head length. Snout length 17.1% (16.9–20.4,  $\bar{x}$  = 17.9) [11.9–16.3,  $\bar{x}$  = 14.1] of bony head length. Least bony interorbital width 39.0% (38.7–42.3,  $\bar{x}$  = 40.5) [37.5–43.8,  $\bar{x}$  = 40.4] of bony head length.

Dorsal-fin rays ii,9 in all specimens (last ray not split to its base). Dorsal-fin length (=dorsal-fin origin to distal tip of longest ray when fin adpressed to back) damaged (31.2–33.1,  $\bar{x}$  = 32.1,  $n$  = 3) [29.3–32.1,  $\bar{x}$  = 30.4]. Distal margin of dorsal fin convex in both sexes (Figs. 3, 4).

Adipose fin present. Anal-fin rays iv,25 (iv,25 in two, iv,27 in one, and iv,28 in one, males) [iv,25 in one, iv,26 in one, iv,27 in three, and iv,28 in two, females]. Last anal-fin ray split to its base. Anterior distal margin of anal fin convex, posterior distal margin concave (Fig. 4).

Anal-fin spines as follows on a male alizarin preparation, SL 29.5 mm, USNM 220757. Second branched anal-fin ray first to bear spines. This ray and next 8 rays bear 5 spines on each ray, 1 for each ray segment that bears spines. Spines and their respective segments occur consecutively 6 or 7 segments from distal end of fin rays. Spines occur only on posterior segments of branched portions of rays when they occur on branched portions of rays. Eleventh branched ray bears 4 spines, twelfth and thirteenth branched rays with 3 spines and fourteenth with 1 spine. Each spine relatively short, conical and extends dorsally and laterally. In a large, old male

specimen, SL 38.5 mm, USNM 220732, about 17 rays bear spines. First anal-fin ray to bear spines is posteriormost unbranched ray. Number of spines per ray about same as in smaller specimen but spines extend in a more lateral direction than in smaller specimen. Spines occur on both sides of anal fin. Females without anal-fin spines.

Pectoral-fin rays i,14 (i,12 in one, i,13 in three) [i,12 in one, i,13 in three, i,14 in two, and i,15 in one]. Posterior tip of longest pectoral-fin ray reaching beyond pelvic-fin origin. Pectoral-fin length 24.2 (21.8–24.6,  $\bar{x}$  = 23.3) [21.1–24.2,  $\bar{x}$  = 22.2]. Distal pelvic-fin tip reaching to or somewhat beyond anal-fin origin in both sexes. Pelvic-fin rays i,5 in all specimens.

Pelvic-fin length 14.7 (11.7–14.7,  $\bar{x}$  = 13.6) [12.4–14.2,  $\bar{x}$  = 13.3]. Second branched ray of pelvic fin bears 8 spines and third ray bears 6 spines in a male specimen, SL 29.5 mm, USNM 220757. These spines relatively elongate, curved, and conical, with their sharp apices directed medially. These spines only occur on ventral surface of fin. A male specimen, SL 38.5 mm, USNM 220732, bears 11 spines on its second branched pelvic-fin ray and 9 spines on its third branched ray. Females without pelvic-fin spines.

Caudal fin 10/9 in all specimens, its dorsal and ventral lobes equal in length. Caudal fin, dorsal fin, and pectoral fin without bony hooks.

Scales cycloid. Lateral line incomplete, perforated lateral-line scales 5, (4–5,  $\bar{x}$  = 4.5,  $n$  = 12, in both sexes). Scales in a lateral series 36 (33–39,  $\bar{x}$  = 36.5,  $n$  = 12, in both sexes). Scale rows between dorsal-fin origin and pelvic-fin origin 15 (14–15,  $\bar{x}$  = 14.4,  $n$  = 12, in both sexes). Predorsal scales 18 (17–19,  $\bar{x}$  = 18.2,  $n$  = 12, in both sexes).

Premaxillary teeth in 2 rows. Outer row teeth unicuspid and 1 to 2 in number. Usually these teeth placed far back, against and nearly between inner row teeth, causing Myers (1926) to describe premaxillary teeth as occurring in a single row. Occasionally an outer row tooth well forward of inner row teeth. Outer row teeth lie between first and second inner row teeth and/or second and third inner row teeth. Inner row teeth 5 to 6, medialmost bicuspid or tricuspid but with a very tiny medial cusp. Proceeding laterally and posteriorly next 1 to 3 teeth tricuspid or sometimes 1 or 2 of these bicuspid or unicuspid. Posteriormost 1 to 2 teeth usually unicuspid, occasionally bi- or tricuspid. Maxillary bone with 8 to 14 mostly unicuspid teeth, occasionally anteriormost tooth tricuspid. Teeth occur along about anterior one-half to nearly two-thirds of maxillary length. Dentary with a single row of teeth. Anterior 5 (sometimes only 4) teeth large and tricuspid; posterior 6 to 8 teeth small and unicuspid. Ectopterygoid and palatine without teeth.

Total vertebrae including Weberian apparatus and terminal complex centrum 34–36,  $\bar{x}$  = 35.4,  $n$  = 10. Gill rakers 7/10 in lectotype, 3–7 on upper limb, 10–12 on lower limb, never more than a total of 18 or less than 13 rakers,  $\bar{x}$  = 15.5,  $n$  = 10.

*Color in alcohol.*—Body dark, sometimes almost black in freshly preserved specimens caught in black acid waters with a black muddy substrate. Dark chromatophores most dense on back, becoming less dense ventrally (Fig. 3). Scattered, relatively dark chromatophores on all fins except adipose fin which is pale with very small scattered dark chromatophores. Area of medial rays of pectoral fins with dark chromatophores on membranes between fin rays. Sides of head, eye, and operculum with scattered dark chromatophores. Pigment on sides of body and head silvery beneath dark chromatophores.

*Color in life.*—This color description is from an aquarium specimen kept in dark acid water with a dark sandy substrate. Brown to black pigment about same as described above for color in alcohol. Back olive brown, especially in area anterior to dorsal fin, top of head, along dorsal part of back, ventral and posterior to dorsal fin. Dorsal part of caudal peduncle olive brown; see dark area along back in Fig. 4. Adipose fin bright deep red in both sexes. Eye silvery yellow with dorsal portion rusty red. Snout and distal portion of lower jaw olive brown. Pale areas of cheek and operculum in Fig. 4 yellowish silver in color. Dark areas of operculum brown. Abdominal area silvery yellow on sides, ventrally silvery white. Area dorsal to anal fin silvery blue with much pale pink or pale purple pink color. Pectoral fin hyaline with pale yellow color in male. Pelvic fin yellow brown distally. Anal fin hyaline except about one-third of its distal length forms a yellowish brown border with darker pigment along dorsal portion of this bordering band of color (Fig. 4). Distal tips of anal-fin rays and dorsal-fin rays white. Dorsal fin hyaline except for some brown and yellow pigment in branched portions of first two branched rays and a little of this same pigment distally in succeeding two rays. Caudal peduncle without distinct dark spot but bases of dorsal and ventral caudal-fin lobes with darkened brown pigment. Caudal fin otherwise hyaline except for some yellow color in dorsal portions of dorsal lobe and ventral portions of ventral lobe. A small wild specimen caught in black acid water with a black mud substrate had a very dark brown olive back and sides with scales reflecting golden green along sides of body. Adipose fin intensely blood red. Other pigment of fins and body more intense and darker than aquarium specimen described above.

*Sexual dimorphism.*—In life, males more deeply colored than females and adipose fin a deeper red. Sometimes red of adipose fin slightly less extensive in female than in male. Males may grow larger; in single pair kept in aquaria for three and a half years, male grew to a standard length of 38.5 mm and the female to 34.1 mm. Depth of caudal peduncle different in sexes, 15.3–16.5,  $\bar{x}$  = 15.9% of standard length in males and 13.5–15.3,  $\bar{x}$  = 14.2% in females. Only males have bony hooks in anal and pelvic fins.

*Etymology.*—From Latin *crassus*, thick or stout, and *ceps*, head, in ref-

erence to the stout head of this fish relative to the head of most other characids (Myers, 1926).

*Remarks.*—Jaws, head shape, and caudal peduncle depth all appear to be more derived in *R. crassiceps* than in *R. graciliceps*.

### Acknowledgments

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### Summary

*Rachoviscus graciliceps*, a new species of characid fish, is described from small coastal blackwater streams near Prado, Bahia, Brazil. The relationships of this species appear close to *Rachoviscus crassiceps* Myers (1926), which is redescribed on the basis of a new examination of the types and recently discovered specimens from small blackwater streams along the Atlantic coast about 50 to 60 km south of Paranaguá, Paraná, Brazil. The head is more slender in *R. graciliceps* and the least bony interorbital width is 29.1–35.0% of the head length while *R. crassiceps* has a bony interorbital width 37.5–43.8% of the head length. The caudal peduncle of *R. graciliceps* is much more slender, being 93.0–100% of its depth, while in *R. crassiceps* the caudal peduncle length is 62.7–74.1% of its depth. *Rachoviscus graciliceps* has 14 transverse scale rows around the caudal peduncle whereas *R. crassiceps* has 18. Other differences are noted in the text.

Myers (1926) tentatively considered *Rachoviscus* to be related to *Prionobrama*, and Géry (1977) suggested that it might be related to *Prionobrama* or *Paragoniates*. *Rachoviscus* and *Paragoniates* might be related but we think it doubtful. Too little is known about these fishes for useful hypotheses about their relationships. The genus *Rachoviscus* is redefined and the type locality of *R. crassiceps*, stated as being the neighborhood of Rio de Janeiro,

is discussed. Since the original specimens described by Myers (1926) were imported into Germany for the aquarium trade and since the fish has never been found again in the vicinity of Rio de Janeiro, it may be that the fish was originally imported from Paranaguá and transshipped to Germany through Rio de Janeiro.

### Resumo

*Rachoviscus graciliceps*, uma nova espécie de caracídeo, é descrita de um pequeno riacho litorâneo, de água preta, próximo à cidade de Prado, Estado da Bahia, Brasil. Esta espécie está intimamente relacionada com *Rachoviscus crassiceps* Myers (1926) a qual é aqui redescrita com base em novo exame dos tipos e exemplares recentemente colecionados em pequenos córregos, de água preta, ao longo da costa atlântica, distando cerca de 50 a 60 quilômetros ao sul da cidade de Paranaguá, Estado do Paraná, Brasil. As duas espécies podem ser distinguidas pelos seguintes caracteres: a forma da cabeça é mais delgada em *R. graciliceps* e a memor largura óssea interorbital é de 29,1 a 35,0% do comprimento da cabeça enquanto que *R. crassiceps* tem uma largura óssea interorbital de 37,5 a 43,8% do comprimento da cabeça. O pedúnculo caudal de *R. graciliceps* é muito mais delgado, sendo o seu comprimento cerca de 93,0 a 100% da sua altura enquanto que em *R. crassiceps* o comprimento do pedúnculo caudal é de aproximadamente, 62,7 a 74,1% de sua altura. *R. graciliceps* possui 14 fileiras transversais de escamas em torno do pedúnculo caudal enquanto *R. crassiceps* possui 18 fileiras. Outras diferenças são assinaladas no texto.

Myers (1916) tentativamente considerou *Rachoviscus* relacionado com *Prionobrama*, e Géry (1977) sugeriu um relacionamento entre *Rachoviscus* e *Prionobrama* ou *Paragoniates*. *Rachoviscus* e *Paragoniates* podem ser relacionados mas achamos isso duvidoso. Contudo, pouco se sabe suas esses peixes para que se possa formular hipóteses consistentes sobre suas afinidades. O gênero *Rachoviscus* é redefinido e a localidade típica de *R. crassiceps*, tida como sendo nos arredores do Rio de Janeiro, é discutida. Tendo em vista que os exemplares originais descritos por Myers (1926) foram importados para a Alemanha pelo comércio de aquário e visto que o peixe nunca foi reencontrado nas vizinhanças do Rio de Janeiro, podemos considerar provável que aquele material fosse originalmente importado de Paranaguá e, através do Rio de Janeiro, transportado para a Alemanha. A localidade típica deve ser os arredores de Paranaguá, onde os peixes foram agora colecionados, ao invés do Rio de Janeiro.

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STUDIES ON DECAPOD CRUSTACEA FROM THE  
INDIAN RIVER REGION OF FLORIDA.  
XIX. LARVAL DEVELOPMENT IN THE LABORATORY  
OF *LEPIDOPA RICHMONDI* BENEDICT, 1903,  
WITH NOTES ON LARVAE OF AMERICAN  
SPECIES IN THE GENUS  
(ANOMURA: ALBUNEIDAE)

Robert H. Gore and Cindy Lee Van Dover

*Abstract.*—The complete larval development of a sand crab species attributed to *Lepidopa richmondi* (based on morphological characters seen in the megalopal stage) is described and illustrated, using a first stage zoea obtained from the plankton and cultured in the laboratory. Three zoeal and one megalopal stage were obtained. Zoeal features are compared with those seen in two other western Atlantic and two eastern Pacific species. Data suggest that the zoeal stages may be segregated along the same lines of species groupings established for adults, with Atlantic zoeae differing in telsonal characters from those known in eastern Pacific larvae. This report is the first to describe the complete development for any Atlantic species in the laboratory.

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The genus *Lepidopa*, commonly known as sand crabs, consists of small, filter-feeding intertidal and subtidal marine anomurans which have the carapace and pereopods modified for burying in the substratum. Five species occur in the western North Atlantic, 3 primarily in the Caribbean Sea, and 2 reaching continental waters of the United States. The complete larval development of these crustaceans remains unknown. Johnson and Lewis (1942) and Knight (1970) described larvae of an eastern Pacific species attributed to *Lepidopa myops* Stimpson, 1860 [since considered by Efford (1971) to be larvae of *L. californica*]. In the same paper, Knight described and illustrated the planktonic larvae of a second species she called *Lepidopa* species "B." In the Atlantic, the only description of *Lepidopa* larvae is that of Sandifer and Van Engel (1972) who described and illustrated 3 zoeal stages of a species obtained from Chesapeake Bay plankton, which they attributed to *L. websteri* Benedict 1903, because it was the only species known to reach Virginian coastal waters. The second continental species, *L. benedicti* Schmitt, 1935, occurs in the Gulf of Mexico and along the southeastern and central eastern Florida coastline (Holthuis, 1960; Efford, 1971; Gore, unpublished).



On 19 September 1972, a single albuneid zoeal stage I was collected from the plankton 2 miles east of Jupiter Inlet, Martin County, on the central eastern Florida coast. This specimen, originally maintained in the laboratory as a matter of curiosity, completed its zoeal development and attained megalopal stage, but unfortunately died without molting to crab stage I. Morphological features of the frontal margin of the carapace, the walking legs, third maxillipeds and second abdominal somite, were sufficiently developed in the megalopa to suggest that the species observed was *Lepidopa richmondi* Benedict, 1903 (see Discussion). In view of the limited amount of knowledge on larval development in the Albuneidae we provide herein a description of the zoeal and megalopal stages of what we believe to be *L. richmondi*. If our identification of the megalopa is correct, it indicates that larvae of *L. richmondi* occur in neritic waters along the eastern Floridan continental shelf, although adults have yet to be discovered there.

### Materials and Methods

The single first zoeal stage was maintained in the laboratory in a glass finger bowl with 250 cc of seawater (35‰ salinity). Fresh *Artemia* nauplii and *Chlorella* sp. algae were provided and water was changed daily. Room temperature of about 24°C ( $\pm 0.5^\circ\text{C}$ ) was obtained using closed circuit air-conditioning. Upon attaining megalopal stage the specimen was transferred to a 500 cc glass bowl containing sieved, autoclaved quartzite sand in hopes that crab stages could be obtained in order to positively identify the species. As noted, the specimen died before this occurred. The description that follows is based on the molted carapaces and dissected appendages of the zoeal stages, and the partial dissection of the megalopal stage. Methodology was identical to that used by Gore (1973).

### Results and Discussion of the Rearing Experiment

When collected on 19 September 1972 the specimen was obviously in the first zoeal stage as determined by the fixed eyes, and the presence of 4 natatory setae on the maxillipeds. The second and third zoeal stages were attained on 22 and 28 September, followed by the megalopal stage on 6 October. Although the duration of the first zoeal stage is unknown (certainly at least 4 days, and probably 7–8 days if second stage duration can be used as an equivalent; see Knight, 1970), the overall developmental time in the plankton was at least 18 days based on molting occurrence in the laboratory. Examination of the megalopa which died in day 4 of that stage gave no indication of imminent molt, so that we may extrapolate a planktonic and postlarval duration of at least 3 weeks or so for the species at 24°C, before the first crab stage is attained.

This is substantially less time than the 45–53 days required for *L. cali-*



*fornica* to reach first crab (Knight, 1970). However, that species, and the larvae attributed to *L. websteri* by Sandifer and Van Engel (1972) possessed 4 zoeal stages, so that extended duration would be suspected. Unfortunately, because they were working with larvae obtained from the plankton, the latter authors provided no duration-in-stage data. It thus appears that *L. richmondi* differs from other known members of the genus in its developmental sequence, possessing 3 instead of 4 zoeal stages. This assumes, of course, that laboratory development in this species did not accelerate the zoeal sequences and cause a late stage to be skipped. In this respect, our third stage zoea resembled that figured by Sandifer and Van Engel in possessing well-formed uropods and six abdominal somites, but differed in having well-developed pleopod buds which were lacking in Sandifer and Van Engel's third stage zoea. Presence of pleopod buds usually indicates the molt to megalopa is imminent, although some species of galatheid zoeae may pass through one additional stage before reaching postlarvae (Gore, 1979).

If *L. richmondi* does pass through only 3 zoeal stages it might explain in part the relative distribution of the species which seems to be confined to the Caribbean Sea and southward to Brazil. Shortened zoeal development, perhaps larvae entrained in local current gyres, would tend to hold the species in a more limited geographic area. The species' farthest occurrence northward is the islands of Puerto Rico and Jamaica (Holthuis, 1960; Efford, 1971), and the single larva used in this study could have come from either locality.

### Description of the Larvae

*First zoea*.—(Carapace length 1.6, rostral spine 4.6, posterior carapace spine 2.6 mm.)

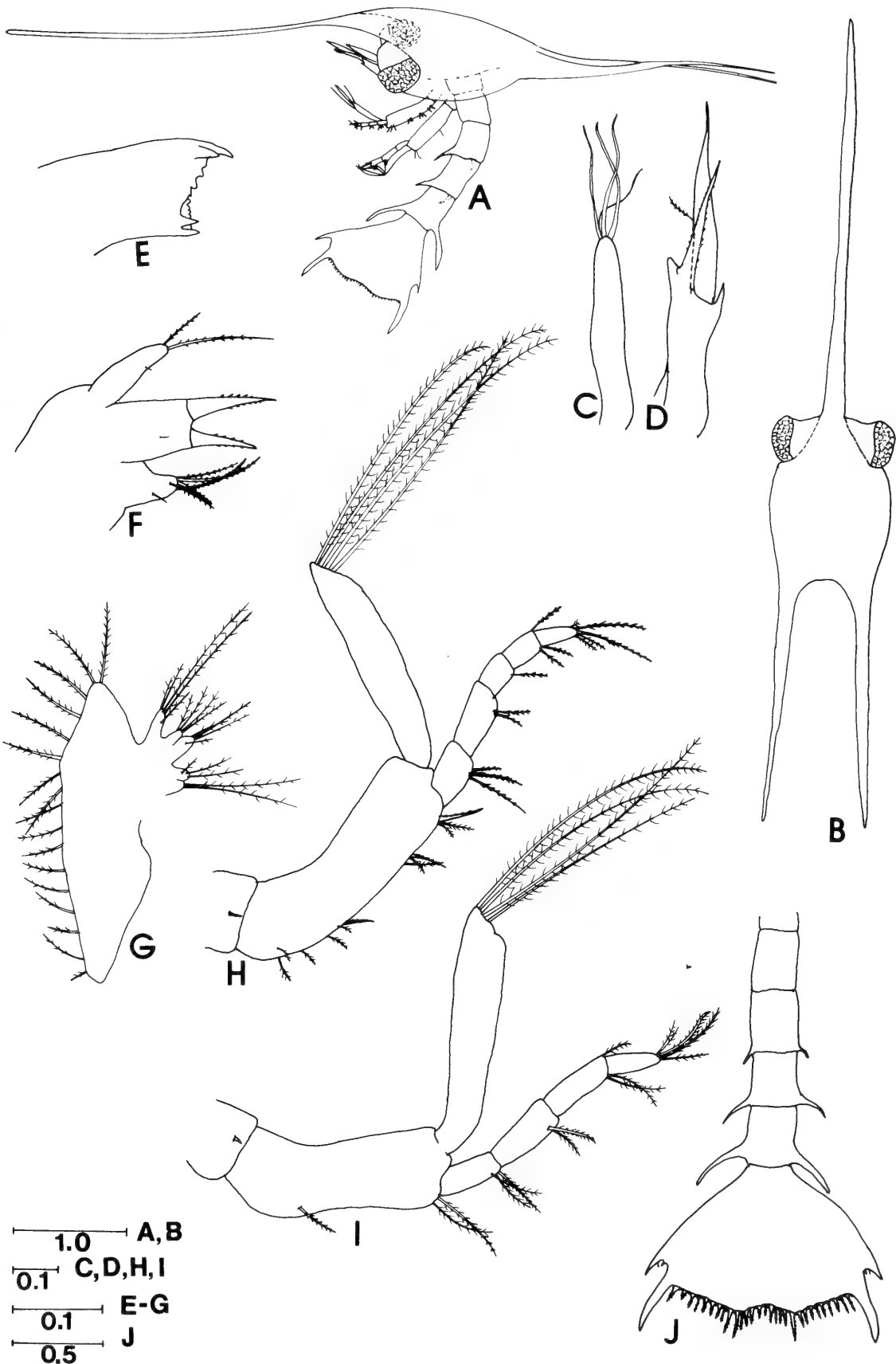
Carapace (Fig. 1A, B): Smooth, somewhat inflated, ovoid; with elongate rostral and posterior carapace spines, former 2.9, latter  $1.6\times$  carapace length, all smooth, unarmed. No setae observed on carapace. Eyes unstalked.

Antennule (Fig. 1C): Flabellate rod, 3 aesthetascs, 1 seta.

Antenna (Fig. 1D): Protopodite a slender, dagger-like process armed on distal  $\frac{3}{4}$  with rows of serrated teeth. Exopodite an elongate tapering process,  $1.6\times$  longer than protopodal spine, a single plumose seta medially. Basal segment with a single short spine distally at junction with exopodite. En-

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Fig. 1. *Lepidopa richmondi*, first zoea: A, Lateral view; B, Dorsal view; C, Antennule; D, Antenna; E, Mandible; F, Maxillule; G, Maxilla; H, Maxilliped 1; I, Maxilliped 2; J, Abdomen and telson. Scale lines in mm.



dopodite a short bud adjacent to protopodal spinous process. General form of antenna remains similar through subsequent stages, but relative proportions of processes change.

Mandible (Fig. 1E): Asymmetrical dentate processes, no palp.

Maxillule (Fig. 1F): Endopodite unsegmented, 2 terminal setae, a subterminal hair; basal endite with 2 strong spines plus a small hair laterally; coxal endite with 5 strong setae plus a lateral hair.

Maxilla (Fig. 1G): Endopodite unsegmented, 4 terminal, 1 subterminal seta (2 quite long); basal endite proximal and distal lobes each with 4 setae; coxal endite with 3 and 2 long setae on distal and proximal lobes, respectively; scaphognathite an elongate sublanceolate lobe with 17 setae.

Maxilliped 1 (Fig. 1H): Coxopodite with a single spinule; basipodite setal formula progressing distally 3, 3, 3, 3; distal triads each with heavy serrate seta as shown; endopodite 5-segmented, setal formula 3, 2, 1, 2 + I, 5; exopodite a single segment, 4 natatory setae. (Note: Roman numeral denotes dorsal seta.)

Maxilliped 2 (Fig. 1I): Coxopodite with a single spinule; basipodite setal formula 1, 2; endopodite 4-segmented, setal formula 3, 2, 2 + I, 5; exopodite single segment with 4 natatory setae.

Maxilliped 3 and pereopod buds: Present but too diaphanous to illustrate from molt.

Abdomen and telson (Fig. 1J): Five somites, third to fifth with posterolateral spines increasing in size toward telson; latter a roundly spatulate process, with two pairs lateral spines, distal  $3\times$  length of proximal, former with a small spine plus thin anomuran hair in axil; telson width  $1.8\times$  length, posterior margin with 29 spines of varying length, ninth or ninth and tenth from exterior noticeably longer than others; no dorsal or ventral setae noted on telsonal surface. In the terminology used by Gore (1979) for this type of telson, the setal formula reads: I + ii + 3 + IV + 5-18.

Color: Not noted; no chromatophores visible in molts.

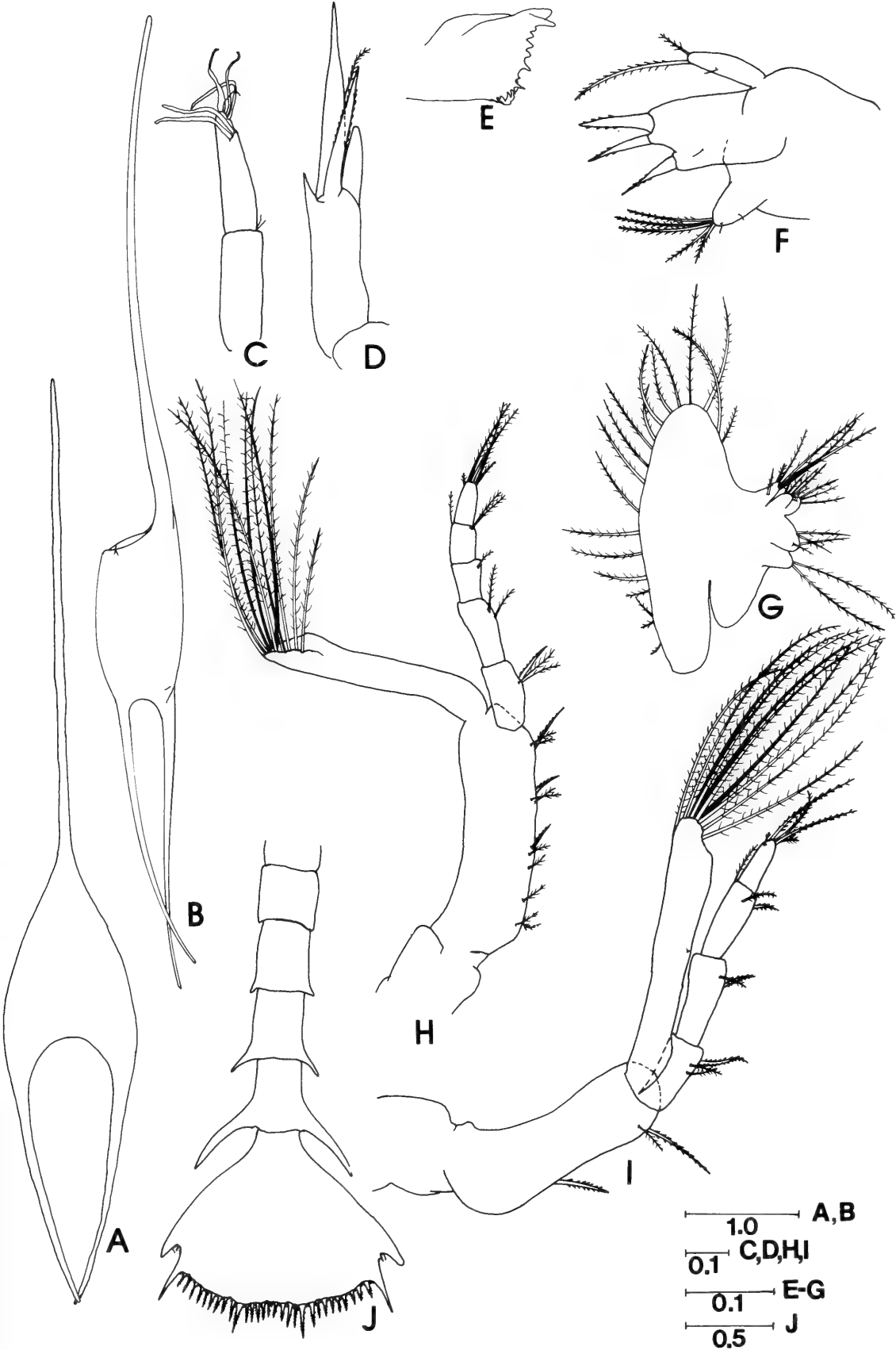
*Second zoea.*—(Carapace length 1.9; rostral spine 5.7; posterior carapace spine 2.6 mm.)

Carapace (Fig. 2A, B): Similar to stage I, but larger; rostral spine  $3\times$ , posterior carapace spine  $1.4\times$ , carapace length, all smooth, unarmed. Carapace now with small anterolateral spinule subocularly; eyes mobile.

Antennule (Fig. 2C): Two-segmented, distal with 1 apical, 2 subapical, 2 lateral aesthetascs; 1 thin apical, 2 basal setae, latter at junction of proximal segment as shown.

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Fig. 2. *Lepidopa richmondi*, second zoea: A, Dorsal view; B, Dorsolateral view; C, Antennule; D, Antenna; E, Mandible; F, Maxillule; G, Maxilla; H, Maxilliped 1; I, Maxilliped 2; J, Abdomen and telson. Scale lines in mm.



Antenna (Fig. 2D): Exopodite  $1.6\times$  length of protopodal spine,  $3.1\times$  length of endopodite; latter about half length of protopodal spine; basal spine at junction of exopodite slightly larger.

Mandible (Fig. 2E): Relatively unchanged from stage I, teeth sharper, more numerous.

Maxillule (Fig. 2F): Endopodite and coxal endite unchanged from stage I, except latter with additional fine seta laterally; basal endite with additional strong spine.

Maxilla (Fig. 2G): Endopodite with 5 terminal, 1 subterminal setae; basal endite unchanged from first stage; coxal endite distal lobe with 3 terminal, 1 subterminal setae; proximal lobe unchanged; scaphognathite with 19 marginal setae.

Maxilliped 1 (Fig. 2H): Coxopodite without spinule; basipodite and endopodite unchanged from first stage; exopodite with 10 natatory setae.

Maxilliped 2 (Fig. 2I): As in first stage, now lacking coxopodal spinule; exopodite with 10 natatory setae.

Abdomen and telson (Fig. 2J): Five somites, configuration and armature similar to stage I, but spine on somite 3 reduced; telson process formula remains  $I + ii + 3 + IV + 5-18$ ; movable spines 9-10 larger than preceding or succeeding spines; a reduced median spinule present; telson otherwise without surface setae, its width  $1.4\times$  length.

*Third zoea.*—(Carapace length 2.9; rostral spine 7.7; posterior spine 4.2 mm.)

Carapace (Fig. 3A, B): Similar to previous stage but larger, more inflated; rostral spine  $2.7\times$ , posterior carapace spine  $1.4\times$ , carapace length, unarmed. Anterolateral spinule larger.

Antennule (Fig. 3C): Distal segment more elongate relative to proximal, bearing 7 aesthetascs, 3 setae progressing distally as 2, 2, 2, 1 + 3 setae; 2 small, 2 larger thin setae at junction of proximal and distal segments; former with single seta medially.

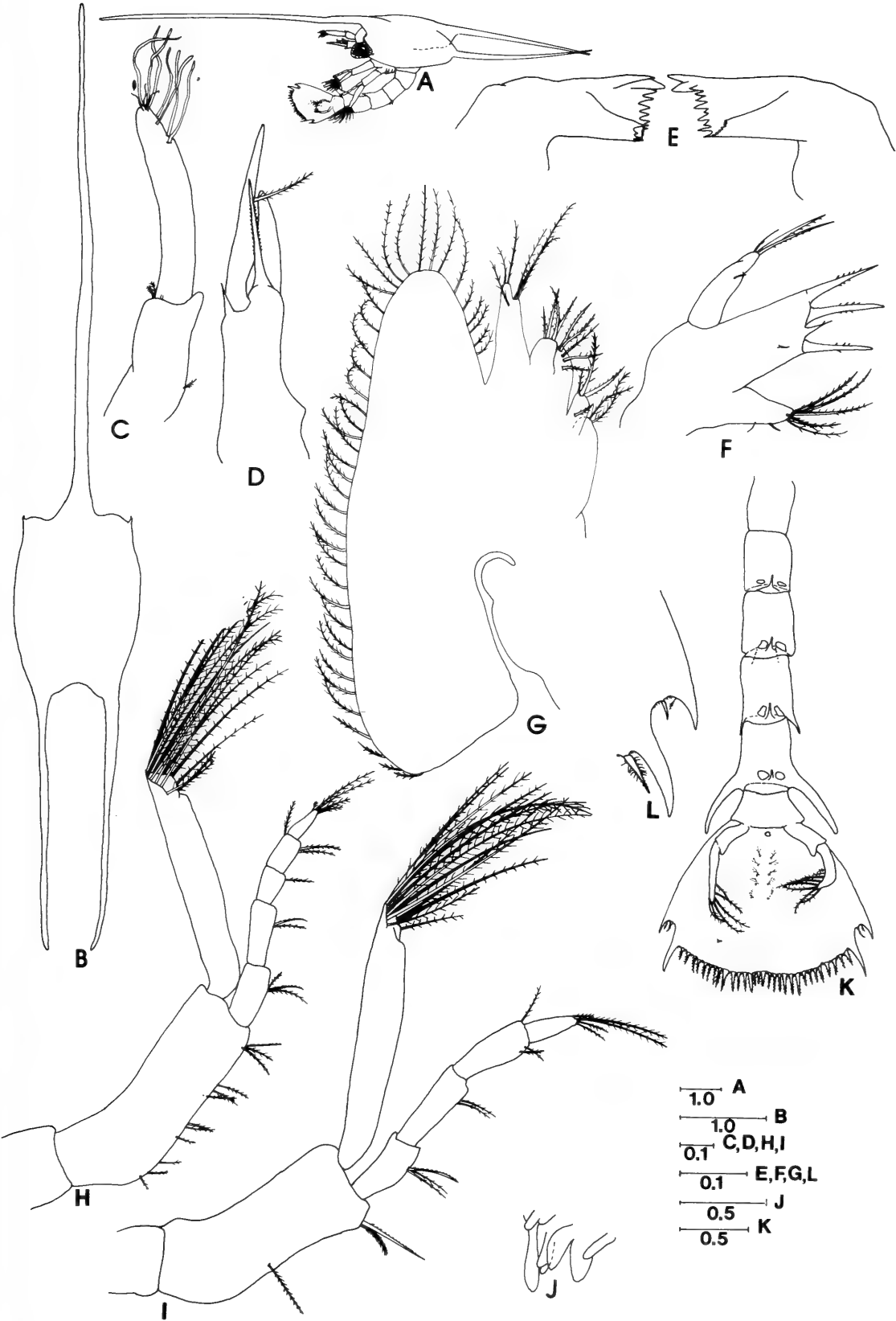
Antenna (Fig. 3D): Exopodite  $1.8\times$  protopodal spine,  $2.0\times$  endopodite length, latter just slightly shorter than protopodal spine; basal spine at junction of exopodite unchanged.

Mandibles (Fig. 3E): Becoming distinctly scoop-shaped, with larger teeth; no palp.

Maxillule (Fig. 3F): Endopodite with 3 terminal setae plus usual subterminal hair; basal endite with 4 strong spines plus lateral seta; coxal endite with 5 terminal, 1 subterminal, and 2 lateral setae as illustrated.

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Fig. 3. *Lepidopa richmondi*, third zoea: A, Lateral view; B, Dorsal view; C, Antennule; D, Antenna; E, Mandibles; F, Maxillule; G, Maxilla; H, Maxilliped 1; I, Maxilliped 2; J, Maxilliped 3 and pereopods; K, Abdomen and telson; L, Detail, telsonal lateral spines. Scale lines in mm.



Maxilla (Fig. 3G): Endopodite setae unchanged from previous stage, now noticeably separated into lobes, progressing apically as 1 + 3 + 2; basal endite proximal lobe with additional strong seta, all other lobes unchanged; scaphognathite with 41 marginal setae.

Maxilliped 1 and 2 (Fig. 3H, I): Unchanged except for exopodites, bearing 14 and 13 natatory setae, respectively; serrate basal spines quite noticeable.

Maxilliped 3 and pereopods (Fig. 3J): Undivided and amorphous buds, latter without evidence of chelation or segmentation.

Abdomen and telson (Fig. 3K, L): Now with 6 somites, spine on somite 3 absent; pleopod buds on somites 2–5; somite 6 with uniramous, two-segmented setose uropods; telson 1.5× wider than long, with 5 pairs of thin setae in longitudinal row dorsally; posterior marginal formula I + ii + 3 + IV + 5–19, ninth process noticeably larger than adjacent movable spines; under high magnification (20×) a series of very small spinules interspersed among all processes (Fig. 3L).

*Megalopa*.—(Carapace length × width 3.0 × 2.5 mm.)

Carapace (Fig. 4A, B): Dorsoventrally depressed, subrectangular, more or less smooth, areas poorly delineated, marginally setose from anterolateral to branchial regions; anterolateral and outer orbital spines distinct; rostral spine thin, elongate, reaching distal margin of second antennal segment; orbits deeply excavate, concave, with marginal setae; remnants of posterior carapacial spines on posterolateral margin of carapace; a transverse row of fine hairs on frontal region, a similar but shorter row on cardiac area.

Abdomen (Fig. 4C): Six somites, 2–5 with expanded, setose pleura, decreasing in size distally; paired biramous pleopods on somites 2 (Fig. 5K) through 5 (Fig. 5L), *appendices internae* on endopodites of 3, 4, 5, and varying numbers of setae present; exopodites becoming more setose progressing toward telson. Somite 6 with biramous uropods, setose as illustrated, but protopodite naked (Fig. 5M).

Telson (Fig. 4C): Width 1.4× length; subcircular, bearing remnants of larger lateral spines of zoeal telson, plus marginal setae as shown; dorsal longitudinal row of 5 pairs of thin setae still present, additional transverse and grouped setae along anterior and anterolateral margin as illustrated.

Antennule (Fig. 5A, B): Peduncle 3-segmented, a minute palp-like ventral flagellum, an elongate 24-segmented setose dorsal flagellum, latter with aesthetascs on terminal 3 segments, placed as shown in detail (Fig. 5B); other setae as illustrated.

Antenna (Fig. 5C): Three-segmented, enlarged peduncle, basal segment with lamellar setose lobe; third with short proximally setose scaphocerite, a longer 9-segmented dorsal flagellum; fourth segment from tip with 2 small palp-like processes.

Mandible (Fig. 5D): Marginally dentate scoop-shaped process; an en-

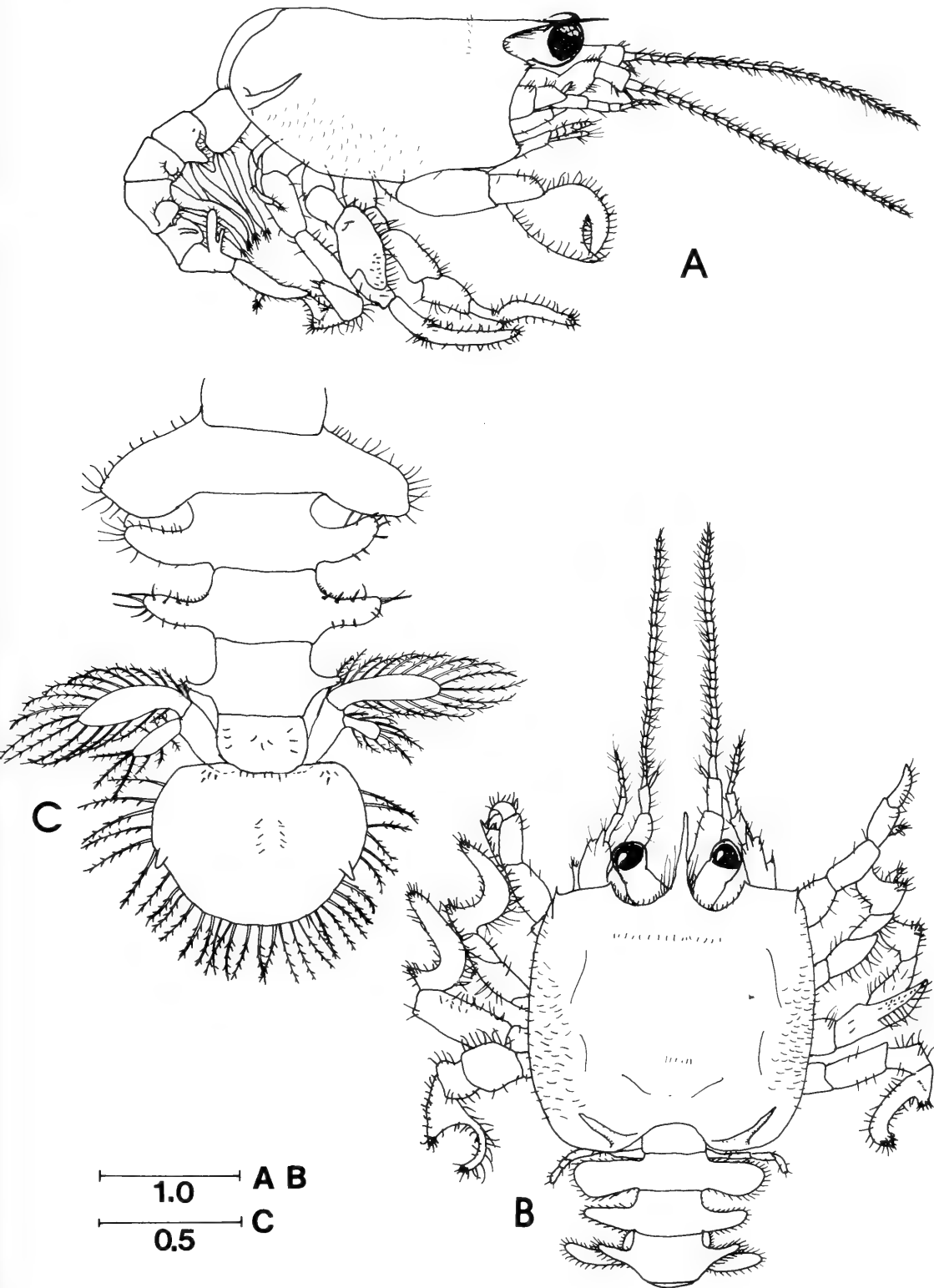


Fig. 4. *Lepidopa richmondi*, megalopa: A, Lateral view; B, Dorsal view; C, Abdominal somites and tail fan. Scale lines in mm.



larged 3-segmented palp, armed with strong setae and sharp spines as shown.

**Maxillule (Fig. 5E):** Endopodite elongate, basally inflated, folded back on itself distally, a single seta from protuberance on proximal lobe; basal endite with 15 strong spines and setae plus a thin seta laterally; coxal endite 12 apical, 2 lateral strong spines and setae; protopodal lobe basally with short sharp spine, an elongate plumose seta, plus a short stout seta.

**Maxilla (Fig. 5F, G):** Endopodite distally naked, with 3 minute setae basally; basal and coxal endites with varying number of setae, not exactly determined because of fragility, appearing as  $11 + 1$ ,  $5 + 1$  on distal and proximal lobes of former,  $3 + 1$ ,  $3 + 2? + 2?$  on respective lobes of latter; what appears to be either a foreshortened epipod, or modified arthrobranch bud present on basal lobe; a second, rectangular setose lobe apparent proximally; scaphognathite with 101 marginal setae in addition to scattered short hairs on lateral surface.

**Maxilliped 1 (Fig. 5H):** Endopodite 5 segmented, setae progressing distally 3, 1, 1, 1, 0; exopodite 2-segmented, distalmost flattened, ovoid, with plumose marginal setae; protopodite with expanded, setose and spinose distal basal lobe, plus somewhat amorphous coxal lobe bearing 2 setae; a recurved epipod present.

**Maxilliped 2 (Fig. 5I):** Endopodite 5-segmented, setose and spinose as illustrated; exopodite 2-segmented, proximal segment about  $4\times$  length of distal, with 4 long setae from distomedial lobe of former, 7 plumose apical setae on latter; protopodite sparsely setose, with rudimentary epipod.

**Maxilliped 3 (Fig. 5J):** Endopodite 5-segmented, clothed with long bristle-like setae; antepenultimate segment developed distally into rounded lobe reaching about half length of penultimate segment; exopodite weakly calcified, naked; no epipod observed.

**Pereopods (Fig. 6A–G):** Pereopod 1 chelate, heavily setose; chela height  $0.8\times$  length, carpus  $1.6\times$ , merus  $2.1\times$  longer than wide; pereopods 2–5 as illustrated, merus of third with plumose seta plus scattered small spinules, carpus with longer spine-like setae; dactyls of all walking legs variably falcate; fifth pereopod indistinctly chelate, armed apically with several short sharp teeth, plus long setae, entire appendage considerably reduced in size relative to other pereopods.

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Fig. 5. *Lepidopa richmondi*, megalopa: A, Antennule; B, Detail, terminal segments of antennule; C, Antenna; D, Mandible; E, Maxillule; F, Maxilla; G, Maxilla, detail of scaphognathite seta; H, Maxilliped 1; I, Maxilliped 2; J, Maxilliped 3; K, Pleopod, somite 2; L, Pleopod, somite 5; M, Uropod, somite 6. Scale lines in mm.



### Discussion

The zoeal larvae of the Albuneidae are quite as distinctive as those of the Porcellanidae, another anomuran family, to which they show obvious morphological relationships. Larvae in both families possess elongate rostral and paired posterior carapacial spines. However, albuneid larvae and particularly those assigned to the genus *Lepidopa* are quickly distinguished from porcellanid zoeae by the possession of an extremely wide roundly or triangularly spatuliform telson, often armed with 2 pairs (instead of one pair) of fixed lateral spines. In addition, the posterior margin of the telson is heavily spinulose, a feature reminiscent of galatheid larvae (also Anomura) in the genus *Munidopsis* (see Samuelsen, 1972; Gore, 1979). *Lepidopa* larvae are further distinguished by having paired, elongate, often recurved spines on the posterolateral margin of the fifth abdominal somite (Knight, 1970), these being absent or reduced in porcellanids.

As presently delineated by Knight (1970) the larvae of *Lepidopa* may be separated from those of *Albunea* most easily by the telson (2 pairs lateral spines, i.e. processes I and IV fixed and enlarged in *Lepidopa*; 1 lateral pair, i.e. only process I fixed in *Albunea*); rostral and posterior carapacial spines greatly lengthened in *Lepidopa*, relatively short in *Albunea*; and the antennal scaphocerite more spine-like in *Lepidopa*, but more blade-like in *Albunea*. Based on these characters, the larvae illustrated by Gurney (1942) as Species A, that identified by Menon (1937) as *Albunea symmista*, and the telson figured by Gurney (1924) can all be considered as *Albunea*. In fact, if Species A is an *Albunea*, and if Gurney's statement is correct that only *Albunea oxyophthalma* [= *A. paretii* fide Monod, 1956] occurs in Bermuda, then Gurney's (1942) larva is a first zoea of *A. paretii* Guérin, 1853.

In the genus *Lepidopa*, larvae from the eastern Pacific (*L. californica* and *L. species B*) possess triangularly spatuliform telsons (see Johnson and Lewis, 1942, pl. 5, fig. 5; Knight, 1970, figs. 40–43, 61–64), whereas those from the Atlantic (see Gurney, 1942, fig. 110A–D; Sandifer and Van Engel, 1972, figs. 1B–3B; and this study) have a more roundly trigonal telson. Efford (1971) in reviewing the American species of *Lepidopa* diagnosed 3 groupings, viz. a *myops* group (including *L. californica*), a *benedicti* group (which contains *L. richmondi*), and a *venusta* group to which *L. websteri* belongs. Presently available data are admittedly scanty, but offer the possibility that larvae in the *myops* grouping may be distinguishable from those of the remaining two groups on telsonal characters alone. If the larvae of *L. websteri* and *L. richmondi* are correctly assigned, then both the *benedicti* and *venusta* group larvae may exhibit similar telsonal characters, i.e. roundly and broadly trigonal, as opposed to more narrowly and triangularly spatuliform telsons seen in known larvae of the *myops* group.

The first zoeal larvae of *Lepidopa* species B [as *Albunea* sp. B] illustrated by Gurney (1942) provides some support for this hypothesis. Although sim-

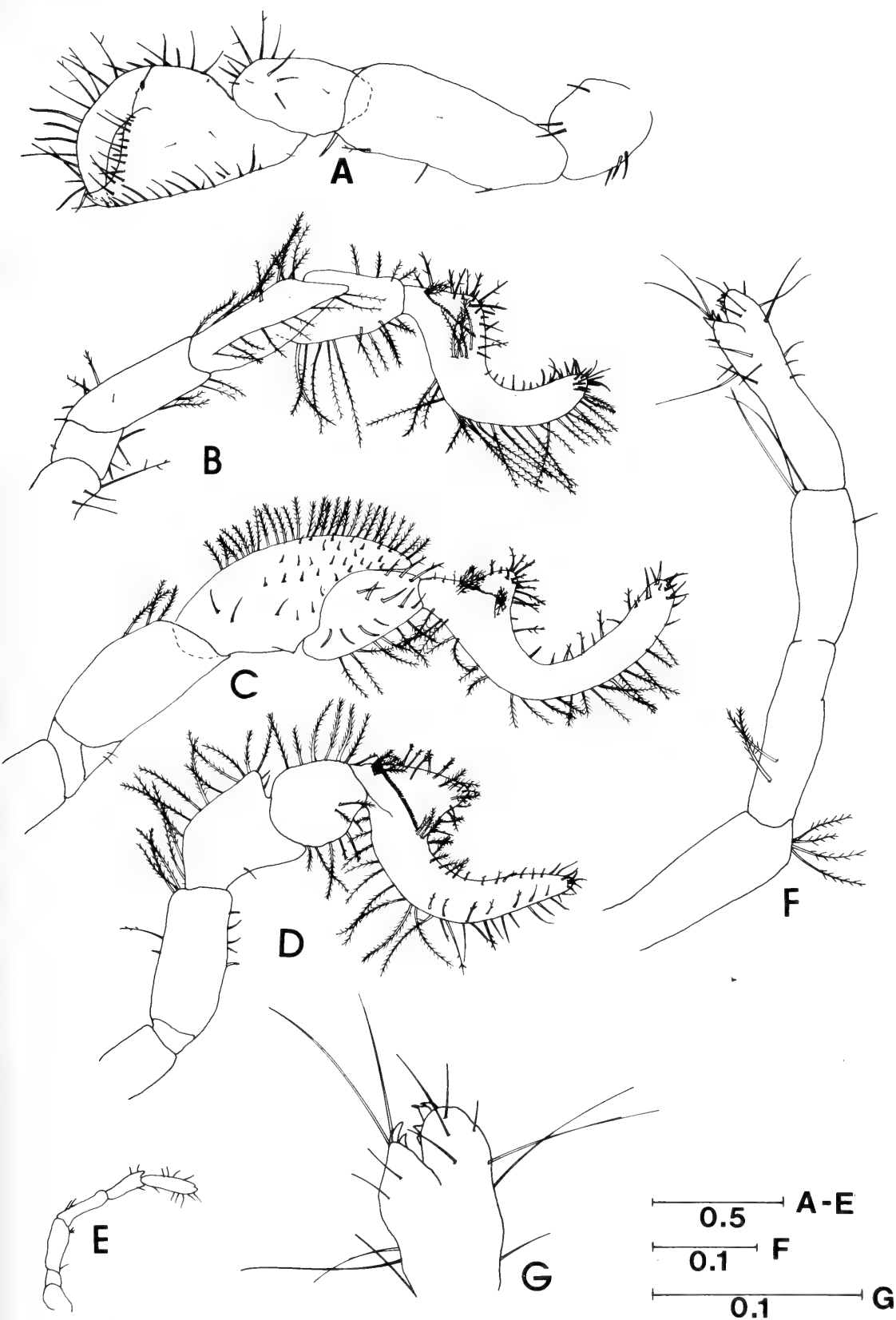


Fig. 6. *Lepidopa richmondi*, megalopa: A, Pereopod 1; B, Pereopod 2; C, Pereopod 3; D, Pereopod 4; E, Pereopod 5; F, Pereopod 5, detail of distal segments; G, Pereopod 5, Detail of cheliform segment. Scale lines in mm.

ilar in most features to first zoeae of *L. websteri* and *L. richmondi*, Gurney's larva is immediately distinguishable by having 3 setae on the antennal exopodite (scaphocerite), whereas the larvae of the 2 other species have but 1 seta there. Inasmuch as only 5 species of *Lepidopa* are presently known from the western Atlantic, with larvae of 2 species more or less completely described, Gurney's larva would presently be assignable to either *Lepidopa benedicti*, *L. venusta*, or *L. distincta*. The first species is known in the Gulf of Mexico from Vera Cruz to western Florida, and in the Atlantic along the Floridan east coast (Efford, 1971; Gore, unpublished) and thus seems the most likely candidate for Gurney's larva. Although the remaining 2 species are not yet known from continental waters of the United States, both are widely distributed throughout the eastern Caribbean and along the eastern coast of South America. While neither *L. venusta* nor *L. distincta* can be completely excluded from consideration, especially because their larvae might possibly become entrained in Antillean/Gulf Stream currents (as apparently do larvae of *L. richmondi*), and thus be carried to Florida or even Bermuda, we can provisionally eliminate *L. distincta* because it belongs to the *myops* group and its larvae may exhibit the triangularly spatulate telson of larvae known from that group. But until more data become available on the species the assignment to groupings remains conjectural for the most part.

In order to provide a comparison among the known larvae of *Lepidopa*, the salient morphological features of the 4 well-described species are presented in Table 1. All that can be said for Gurney's (1942) *Lepidopa* species B is that it shows some similarities to *L. websteri* in maxillary and maxillipedal setation, but differs most noticeably in the scaphocerite of the antenna having 3, instead of 1, marginal setae. In this respect it differs from all known first zoeae in the genus. As can be seen in the Table, maxillipedal setal formulae and antennal endopodite:protopodal spine lengths provide the easiest distinction among the larvae. Other features of some value, but requiring dissection, include maxillulary and maxillary setation, mandibular palp budding, and presence or absence of a coxopodal spine on the maxillipeds. Pleopodal buds appear in stage III of *L. richmondi* (which has no stage IV), but not until the subsequent stage in the other species. Except for the telsonal configuration previously noted, the species are more or less similar in many respects.

Megalopal comparisons are of limited value at present. The only megalopal stages available are those for *L. californica* and the single specimen in our study. A comparison of Knight's (1970) illustration with ours shows the differences between the 2 species most clearly, but morphological features such as setal formulae may eventually prove to be of value when more species become known.

We made specific identification for our study using the following char-

Table 1.—Comparison of selected morphological characters in *Lepidopa* zoeal stages.

	<i>L. californica</i> *	<i>L. sp. B</i>	<i>L. websteri</i>	<i>L. richmondi</i>
ZOE A I				
Carapace length	1.2 mm	1.3 mm	ca. 1.0 mm	1.6 mm
Rostral spine	2.4× cl	2.6× cl	2–3× cl	2.9× cl
Dorsal margin	2 medial knobs	No data	Smooth	Smooth
Antennule	3 aesthetascs 3 setae	3 aesthetascs 3 setae	3 aesthetascs 1–3 setae	3 aesthetascs 1 seta
Antenna				
Endopodite	Absent	Absent	Absent	Short bud
Maxilliped 1				
Coxopodite	Unarmed	Unarmed	Unarmed	1 spine
Endopodite	3, 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2+I, 5
Maxilliped 2				
Coxopodite	Unarmed	Unarmed	Unarmed	1 spine
Endopodite	3, 2, 2, 5	3, 2, 2, 5	3, 2, 2, 5	3, 2, 2+I, 5
Pereopods	Small buds	Small buds	Minute buds	Not seen
Abdomen	Dorsal setae +	Dorsal setae +	No setae	No setae
Lateral spine	3rd pair curved at tips	3rd pair curved at tips	3rd pair curved at tips	3rd pair straight at tips
Telson formula	I + ii + 3 + IV + 5–10 (to 13)	I + ii + 3 + IV + 5–12 (to 15)	I + ii + 3 + IV + 5–14 (to 16)	I + ii + 3 + IV + 5–18
ZOE A II				
Carapace length	1.4 mm	1.5 mm	ca. 1.9 mm	1.9 mm
Rostral spine	3× cl	3.3× cl	No data	3× cl
Antennule				
Aesthetasc- setal formula	2, 2, 1 + 3 setae	2, 2, 1 + 3 setae	2, 2, 1, + 3 setae	2, 2, 1, +1 seta
Basal segment	2 setae	2 setae	0–1 setae	2 setae
Antenna				
Endopodite	“Distinct bud”	Similar	“Small bud”	⅓ Exopodite length
Maxillule				
Coxal endite	5–6 setae	Similar	6 setae	7 setae
Maxilla				
Scaphognathite	13–18 setae	13–20 setae	20–23 setae	19 setae
Maxilliped 1				
Coxopodite	Unarmed	Unarmed	Unarmed	Unarmed
Endopodite	3, 2, 1, 2, 5	Similar	3, 2, 1, 3+I, 5	3, 2, 1, 2+I, 5
Exopodite	8 natatory	9–10 natatory	10 natatory	10 natatory

Table 1.—Continued.

	<i>L. californica</i> *	<i>L. sp. B</i>	<i>L. websteri</i>	<i>L. richmondi</i>
Maxilliped 2				
Coxopodite	Unarmed	Unarmed	Unarmed	Unarmed
Endopodite	3, 2, 2, 5	Similar	3, 2, 2+I, 5	3, 2, 2+I, 5
Exopodite	8 natatory	Similar	10 natatory	10 natatory
Abdomen	No change	No change	No change	Somite 3 spine reduced
Uropods	Not apparent	Similar	Anlage visible	Not apparent
Telson formula	I + ii + 3 + IV + 5–15 (to 18)	I + ii + 3 + IV + 5–17 (to 19)	I + ii + 3 + IV + 5–14 (to 16)	I + ii + 3 + IV + 5–18
ZOEA III				
Carapace length	1.8 mm	1.8 mm	ca. 2.0 mm	2.9 mm
Rostral spine	3 × cl	3.2 × cl	No data	2.9 × cl
Antennule				
Prox./dist. jct.	2 seta	Similar	None?	4 setae
Antenna				
Endopodite	ca. 0.5 × protopodal spine	Similar	“Nearly as long” as protopodite	0.9 × protopodal spine
Mandible	Small palp bud	Similar	No palp	No palp
Maxillule				
Endopodite	2 + 1 setae	Similar	2 + 1 setae	3 + 1 setae
Basal endite	3–4 spines, 1 seta	Similar	3 spines, 1 seta	4 spines, 1 seta
Maxilla				
Basal endite	4, 4 setae	4–5, 4–5 setae	4, 4 setae	4, 5 setae
Coxal endite	2, 2 setae	2–4, 2 setae	3, 2 setae	4, 2 setae
Scaphognathite	13–18 setae	26–33 setae	33–36 setae	41 setae
Maxilliped 1				
Endopodite	3, 2, 1, 2, 5	3, 2, 1, 2+I, 5	3, 2, 1, 3+I, 5	3, 2, 1, 2+I, 5
Exopodite	10–11 natatory	11–13 natatory	13–14 natatory	14 natatory
Maxilliped 2				
Endopodite	3, 2, 2+I, 5	Similar	3, 2, 3+I, 5	3, 2, 2+I, 5
Exopodite	10–11 natatory	12–13 natatory	13–14 natatory	13 natatory
Pereopods	P <sub>1</sub> cheliform	No data	P <sub>1</sub> cheliform	P <sub>1</sub> undivided
Abdomen	Somite 3 spine –	Similar?	Somite 3 spine +	Somite 3 spine –
Pleopods	Absent	Similar?	Absent	Buds, somites 2–5

Table 1.—Continued.

	<i>L. californica</i> *	<i>L. sp. B</i>	<i>L. websteri</i>	<i>L. richmondi</i>
Uropod	Endopod bud +	Similar?	Endopod bud +	No bud observed
Telson formula	Unchanged from previous stage in all species			

\* As *L. myops* in Knight, 1970.

acters in the megalopa: fifth abdominal somite with pleural expansion separates *Lepidopa* from *Albunea*, *Zygopa*, and *Stemonopa* (the latter is not yet known from the western Atlantic); carpus of maxilliped 3 not longer than propodus eliminates the *myops* group of species; absence of subrostral spine eliminates *venusta* grouping; a distinct rostrum, deeply concave orbital margins, abdominal somite 2 truncately rectangular and not directed posteriorly, and the shape of dactylia on pereopods 2, 3, 4, all suggest *L. richmondi* (Efford, 1971, especially figs. 6, 7), and not *L. benedicti*. Regrettably, the groove around the posterior margin of the carapace, an important diagnostic character in adults (and presumably megalopae) of the species, was undeveloped in our specimen. We also feel certain that we were not dealing with *L. websteri* because features in larvae of that species differ from those seen in ours (see Sandifer and Van Engel, 1972; Table 1, this study). Even though the distributional range of *L. benedicti* encompasses the central eastern Florida coast where our first zoeal stage was originally collected (suggesting it was that species) the Caribbean range of *L. richmondi* could easily allow larvae of this species to be entrained in the Florida Current and swept along the Atlantic coast of Florida.

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REVIEW OF *HYSTEROETHYLACIUM* AND  
*IHERINGASCARIS* (BOTH PREVIOUSLY  
=*THYNNASCARIS*) (NEMATODA: ANISAKIDAE)  
FROM THE NORTHERN GULF OF MEXICO

Thomas L. Deardorff and Robin M. Overstreet

**Abstract.**—The genus *Hysterothylacium* Ward and Magath (type-species *H. brachyurum* Ward and Magath) is resurrected to include those species previously considered as members of the junior synonym *Thynnascaris* Dollfus and others described in the genus *Contracaecum* Railliet and Henry that mature in fishes. *Iheringascaris* Pereira is resurrected for *I. inquires* (Linton), the senior synonym of *I. iheringascaris* Pereira. Consequently, we establish 47 new combinations plus present lists of species that may later be shown to be members of *Hysterothylacium*. At least six species of *Hysterothylacium* [*H. fortalezae* (Klein), *H. incurvum* (Rudolphi), *H. chaunaxi* (Olsen), *H. reliquens* (Norris and Overstreet), *H. ogcocephali* (Olsen), and *H. corrugatum* sp. n.] occur in the Gulf of Mexico, and morphological data and a key are presented for these. *Hysterothylacium corrugatum* infecting the swordfish from the Atlantic and Pacific oceans can be characterized primarily by having modified preanal annules ventrally in males and a tail without ornamentation in conjunction with lacking both deep interlabial grooves and flaring cervical alae.

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Several adult nematodes infecting the digestive tracts of finfishes have been described as species of *Thynnascaris* Dollfus, 1933 or *Contracaecum* Railliet and Henry, 1912. Species of *Contracaecum sensu stricto*, however, mature in birds and mammals. Reexamination of *Hysterothylacium brachyurum* Ward and Magath, 1917, as discussed below, reveals it to have the same generic features as species of *Thynnascaris*. Before the genus *Thynnascaris* gains more acceptance, especially in light of potential public health significance of some species (Petter, 1969a, b; Norris and Overstreet, 1976; Norris and Ebert, MS in preparation; Overstreet and Meyer, MS in preparation), we wish to establish the priority of *Hysterothylacium* Ward and Magath, 1917 and *Iheringascaris* Pereira, 1935, transfer known species, and provide data on species of those genera from the Gulf of Mexico.

Most specimens that we collected were removed from hosts, fixed in glacial acetic acid, stored in a solution of 5 parts glycerin and 95 parts 70% ethyl alcohol, and examined in lactic acid or in glycerin after the evaporation of the alcohol. A few others from hosts in museums had been fixed in

formalin and transferred to ethyl alcohol. Many of the common names for fishes follow the American Fisheries Society's list (Bailey, 1970). Sections of worms were stained with Harris' hematoxylin and eosin. Measurements locating the position of the nerve ring are taken from the anterior extremity of the worm to the center of the nerve ring. In spicule ratios, the length of the left spicule equals one. All measurements are in micrometers unless stated otherwise, and figures were drawn with the aid of a drawing tube.

Abbreviations for repositories of examined nematodes or host fish are BMNH—British Museum (Natural History), London, England; GCRL—Gulf Coast Research Laboratory Museum, Ocean Springs, Mississippi; MPM—Meguro Parasitological Museum, Tokyo, Japan; OCI—Oswaldo Cruz Institute, Helminthology Collection, Rio de Janeiro, Brazil; SIO—Scripps Institution of Oceanography, La Jolla, California; TABL—Southeast Fisheries Center, NMFS, Miami, Florida; UMML—Rosenstiel School of Marine and Atmospheric Science, University of Miami, Florida; USNM—National Museum of Natural History, Smithsonian Institution (for fish); USNM Helm. Coll.—United States National Museum, Helminthological Collection, Beltsville, Maryland; VIMS—Virginia Institute of Marine Science, Gloucester Point, Virginia; ZM—Zoologisches Museum, Humboldt-Universität, Berlin, Germany.

### *Hysterothylacium* Ward and Magath

*Hysterothylacium* Ward and Magath, 1917 (type-species *H. brachyurum* Ward and Magath, 1917).

*Thynnascaris* Dollfus, 1933 (type-species *T. legendrei* Dollfus, 1933, junior synonym of *Ascaris cornuta*).

*Thynnascaris*.—Dollfus, 1935 (relegated to subgenus of *Contracaecum*).

*Simplexonema* Kreis, 1952 (as subgenus of *Contracaecum* with *C. (S.) cyclopteri* Kreis, 1952 as type-species).

*Erschovicaecum* Mozgovoi in Skrjabin *et al.*, 1951 (as subgenus of *Contracaecum* with *C. [E.] aduncum* [Rudolphi, 1802] as type-species).

*Acollaris* Araujo, 1970 (as subgenus of *Contracaecum* with *C. [A.] marinum* [Linnaeus, 1767] as type-species).

*Diagnosis*.—Body elongate, reaching greatest width near midbody. Cuticle with annulations moderately or weakly defined or lacking (presumably unreported). Cuticular alae distinct or indistinct. Lips approximately equal in size, usually broader than long, bearing transparent cuticular flanges on lateral margins; flanges with or without indentations; internal pulp usually pedunculated; dorsal lip with 2 lateral doubled papillae; subventral lips with amphid, adjacent mediolateral doubled papilla, and single lateral papilla. Dentigerous ridges absent (not present as indicated by Jackson *et al.*, 1978). Interlabia present; interlabial grooves present or absent. Ventriculus nearly

spherical; ventricular appendage saclike or cylindrical, with septum dividing structure into 2 equal longitudinal pouches; intestinal cecum usually shorter than ventricular appendage. Excretory system with excretory pore located at or near level of nerve ring, with duct extending to at least left lateral cord in which primary excretory canal extending posteriorly (at least in species examined). Rectal glands present or absent (presumably unreported). Spicules similar, alate, equal or slightly unequal in length. Gubernaculum absent. Vulva anterior to midbody. Uterus didelphic, opisthodelphic. Tail conical; tip with or without ornamentation. Medioventral preanal organ usually distinct on preanal fold. Phasmids usually distinct. Parasites of marine, estuarine, and freshwater fishes. Type-species: *Hysterothylacium brachyurum* Ward and Magath, 1917.

*Comparisons.*—Species of *Contracaecum*, especially larval forms, are often confused with those of *Hysterothylacium* primarily because some authors still accept *Contracaecum* in its broad sense. In the strict sense as followed here, even larvae can be distinguished because the excretory pore empties near the ventral interlabium in species of *Contracaecum*, adults of which mature in birds and mammals. Most species related to those in *Hysterothylacium* mature in fishes. Those of *Goezia* Zeder, 1800 have plicated cuticular annulations possessing spines along their rear border, at least as adults, and that of *Iheringascaris* to be reviewed later in this paper has similar annulations but without spines. Other nematodes with a ventricular appendage, intestinal cecum, and excretory pore emptying near level of the nerve ring include members of several genera that need further investigation. *Heterotyphlum* Spaul, 1927 and *Paraheterotyphlum* Johnston and Mawson, 1948 (see Schmidt and Kuntz, 1973; Sprent, 1978) have members with no interlabia; *Lappetascaris* Rasheed, 1965 has one species, and it has no interlabia and considerably modified lips; and *Pulchrascaris* Vicente and dos Santos, 1972 also has one species, and it has no interlabia and its lips have dentigerous ridges. The position of the excretory pore and whether a ventricular appendage exists both need to be determined. Species of *Raphidascaris* Railliet and Henry, 1915, presumably without interlabia, and *Raphidascaroides* Yamaguti, 1941, with them, also are similar to those of *Hysterothylacium* except they lack the intestinal cecum.

*Remarks.*—Dollfus (1933), assuming the type-species lacked a ventricular appendage, erected *Thynnascaris* as a genus, but later (1935a) reduced it to a subgenus of *Contracaecum* Railliet and Henry, 1912 when he realized the appendage was present. Hartwich (1957) resurrected *Thynnascaris*, distinguishing it from *Contracaecum* on the basis of having species that lack a ribbonlike widening of excretory system, have an excretory pore near the level of the nerve ring rather than the ventral interlabium, and mature in fishes rather than in birds and mammals. Yamaguti (1962), basing his classification scheme mainly on the presence of both intestinal and ventricular

diverticula, recognized *Contracaecum* as the only valid genus. In other recent classifications, Chabaud (1965) accepted both *Thynnascaris* and *Contracaecum* and placed them in different tribes of the subfamily Anisakinae, whereas Hartwich (1974) placed *Thynnascaris* in Raphidascariinae (as Raphidascaridinae), and *Contracaecum* in Anisakinae.

None of the above authors accepted *Hysterothylacium* as valid. Yamaguti (1962) followed Van Cleave and Mueller (1934) and considered it a junior synonym of the older *Contracaecum*, whereas Chabaud (1965) and Hartwich (1974), following Yorke and Maplestone (1926) and Baylis and Daubney (1926), considered it a junior synonym of *Raphidascaris* Railliet and Henry, 1915. Gibson (1975), in a review of Hartwich's key, questioned the synonymy, but did not resurrect *Hysterothylacium* nor did he intend to do so (Gibson, personal communication). Margolis and Arthur (1979) briefly discussed the problem. *Hysterothylacium* was erected for *H. brachyurum*, which was considered to lack an intestinal cecum, from the stomach of black bass (= largemouth bass) in Lake St. Clair, Michigan (Ward and Magath, 1917). When Van Cleave and Mueller (1934) examined additional specimens from bass in Oneida Lake, they noted an intestinal cecum, the primary character separating *Contracaecum sensu lato* from *Raphidascaris*. Consequently, they considered *Hysterothylacium* a synonym of *Contracaecum* rather than *Raphidascaris*. Hartwich (1957) assumed Van Cleave and Mueller (1934) had a species different from Ward and Magath's. We, however, examined the type (USNM Helm. Coll. No. 52120) of *H. brachyurum* plus additional other specimens (USNM Helm. Coll. No. 55995) and confirm the presence of an intestinal cecum, ventricular appendage, and excretory pore located near the nerve ring. We therefore consider *Thynnascaris* a junior synonym of *Hysterothylacium* in accordance with replaced sections a and b of Article 23 (Anonymous, 1974) of the International Code of Zoological Nomenclature. The name *Thynnascaris* cannot be considered "long-established," and application of the Law of Priority will not disturb stability or cause confusion, points confirmed by W. I. Follett (California Academy of Sciences, personal communication). The junior synonyms of *Hysterothylacium* other than *Acollaris* listed in the synonymy have been discussed by Hartwich (1957). Araujo (1970) established that subgenus to include those species (without naming them) that we consider *Hysterothylacium*.

By accepting the name *Hysterothylacium*, a number of new combinations must be established (Table 1). For a number of other species, some based on adults and some on larvae, we have not seen type-material and are uncertain of their generic relationships or their validity (Tables 2, 3). Even less information is known for several additional species mentioned by Baylis (1923), Dollfus (1935a), and Punt (1941), but not listed in this paper. Tchérprakoff (1966) described *C. prevosti* Tchérprakoff, 1966 from the emperor penguin and reported the excretory pore as opening posterior to the nerve

ring. Since we know of no species of *Hysterothylacium* infecting a bird, that observation should be confirmed and evaluated.

Hensley and Nahhas (1975) reported *C. brachyurum* from the intestine and ceca of four fishes in the Sacramento–San Joaquin Delta, California, but their specimens were not readily available for us to examine (Nahhas, personal communication). Numerous other references to records from the northern U.S. and Canada are listed by Hoffman (1967) and Margolis and Arthur (1979).

The only other species described as a member of *Hysterothylacium* is *H. cayugensis* Wigdor, 1918 (see Wigdor, 1918), based on immature females infecting *Esox lucius* Linnaeus and *Ictalurus nebulosus* (Lesueur) (as *Ameiurus* n.) in Cayuga Lake, New York. Van Cleave and Mueller (1934) assumed it was conspecific with *H. brachyurum*. No designated type was located, but specimens (USNM Helm. Coll. Nos. 52121 and 52122) from *Esox lucius* in Lake Cayuga and Douglas Lake, Michigan, deposited in 1917 by Wigdor and by A. R. Cooper, respectively, were identified by Wigdor and Magath as *Hysterothylacium* sp., followed by “(=*Raphidascaris* sp.)” on the label. We keyed those to *Raphidascaroides* Yamaguti, 1941 in Hartwich’s (1974) generic key, and consider *H. cayugensis* a *nomen dubium*.

*Hysterothylacium fortalezae* (Klein), new combination

Figs. 1–13

*Contracaecum fortalezae* Klein, 1973:200–210, figs. 1–7 (original description; type-host *Scomberomorus brasiliensis*; type-locality Ceará, Brazil).

**Diagnosis.**—Cuticle with prominent cervical alae; lips with ratio of length to width 1:0.9–1.0; caudal papillar pairs: preanal 13–25; postanal 8; spicules 3–5% of body length; spicule-ratio 1:1.0; tuft of 12–14 relatively large projections at posterior extremity.

**General (based on specimens from Mississippi).**—Body reaching greatest width near midbody. Cuticle with inconspicuous annulations. Alae extending entire length of body; cervical alae prominent, wing-like, extending from base of lips to level of posterior  $\frac{1}{3}$  of esophagus, up to maximum of 30–68 thick (on 5 specimens); caudal alae most prominent at posterior extremity. Lips approximately equal in size, as wide as long; flanges widest near posterior; pulp slightly pedunculated. Interlabia with height equal to or slightly greater than width at base; interlabial grooves lacking. Esophagus 6.4–10.0% of body length. Ventriculus narrower than widest level of esophagus, usually longer than wide; ventricular appendage descending without angulation from posterior portion of ventriculus. Nerve ring located adjacent to anterior 22–34% of esophagus. Excretory pore immediately posterior to level of nerve ring. Tail with tuft of projections at posterior extremity.

Male (based on 3 specimens): Body 12.0–23.4 mm long by 141–432 at

Table 1.—List of new combinations in the genus *Hysterothylacium* parasitizing fishes of the world.

New combination	Original name	Pertinent reference(s)
<i>H. aduncum</i>	<i>Ascaris adunca</i> Rudolphi, 1802	Hartwich, 1975 (compare Punt, 1941; Petter, 1969b; and other cited references)
<i>H. amoyensis</i>	<i>Contracaecum amoyensis</i> Hsü, 1933	Hsü, 1933a, b
<i>H. arii</i>	<i>Contracaecum arii</i> Yamaguti, 1954	Yamaguti, 1954
<i>H. assi</i>	<i>Contracaecum assi</i> Parukhin, 1973	Parukhin, 1973
<i>H. auctum</i>	<i>Ascaris aucta</i> Rudolphi, 1802	Dollfus, 1953; Hartwich, 1975
<i>H. baylisi</i>	<i>Contracaecum baylisi</i> Yamaguti, 1941	Yamaguti, 1941
<i>H. bidentatum</i>	<i>Ascaris bidentata</i> Linstow, 1899	Mozgovoi, 1953 ( <i>A. stroumovi</i> Golowin, 1900, as a junior synonym)
<i>H. carangis</i>	<i>Thynnascaris carangis</i> Kalyankar, 1971	Kalyankar, 1971
<i>H. chaunaxi</i>	<i>Contracaecum chaunaxi</i> Olsen, 1952	Olsen, 1952; this paper
<i>H. clavatum</i>	<i>Ascaris clavata</i> Rudolphi, 1809	Kahl, 1936; Osmanov, 1940; Kreis, 1952
<i>H. coiliae</i>	<i>Contracaecum coiliae</i> Yamaguti, 1941	Yamaguti, 1941
<i>H. cornutum</i>	<i>Ascaris cornuta</i> Stossich, 1904	Baylis, 1923; Dollfus, 1935a; Berland, 1961; Petter, 1969b; Hartwich, 1975 ( <i>T. legendrei</i> Dollfus, 1933, as a junior synonym)
<i>H. cyclopteri</i>	<i>Contracaecum</i> ( <i>Simplexonema</i> ) <i>cyclopteri</i> Kreis, 1952	Kreis, 1952 (considered junior synonym of <i>C. aduncum</i> by Berland, 1961)
<i>H. dollfusi</i>	<i>Thynnascaris dollfusi</i> Schmidt, Leiby, and Kritsky, 1974	Schmidt <i>et al.</i> , 1974
<i>H. epinepheli</i>	<i>Contracaecum epinepheli</i> Yamaguti, 1941	Yamaguti, 1941
<i>H. fabri</i>	<i>Ascaris fabri</i> Rudolphi, 1819	Compare Baylis, 1923; Zhukov, 1960 ( <i>A. biuncinata</i> Molin, 1858, as a junior synonym)

Table 1.—Continued.

New combination	Original name	Pertinent reference(s)
<i>H. fortalezae</i>	<i>Contracaecum fortalezae</i> Klein, 1973	Klein, 1973; this paper
<i>H. gadi</i>	<i>Ascaris gadi</i> Müller, 1776	Johnston and Mawson, 1945; Hartwich, 1975
<i>H. gracile</i>	<i>Contracaecum gracile</i> Yamaguti, 1935	Yamaguti, 1935, 1941
<i>H. habena</i>	<i>Ascaris habena</i> Linton, 1900	Chandler, 1943; Norris and Overstreet, 1975; this paper
<i>H. hapalogenyos</i>	<i>Contracaecum hapalogenyos</i> Yamaguti, 1961	Yamaguti, 1961
<i>H. haze</i>	<i>Thynnascaris haze</i> Machida, Takahashi, and Masuuchi, 1978	Machida <i>et al.</i> , 1978
<i>H. histiophori</i>	<i>Contracaecum histiophori</i> Yamaguti, 1935	Yamaguti, 1935; Olsen, 1952; this paper
<i>H. ilishae</i>	<i>Contracaecum ilishae</i> Yamaguti, 1941	Yamaguti, 1941
<i>H. increscens</i>	<i>Ascaris increscens</i> Molin, 1858	Molin, 1858
<i>H. incurvum</i>	<i>Ascaris incurva</i> Rudolphi, 1819	Baylis and Daubney, 1922; Dollfus, 1935b; Hartwich, 1975; this paper
<i>H. longispiculum</i>	<i>Contracaecum longispiculum</i> Fujita, 1940	Fujita, 1940
<i>H. magnum</i>	<i>Contracaecum magnum</i> Smedley, 1934	Smedley, 1934 (considered probable synonym of <i>H. aduncum</i> by Margolis and Arthur, 1979)
<i>H. marinum</i>	<i>Ascaris marina</i> Linnaeus, 1767	Yamaguti, 1935
<i>H. melanogrammi</i>	<i>Contracaecum melanogrammi</i> Smedley, 1934	Smedley, 1934 (possible synonym of <i>H. aduncum</i> , see Margolis and Arthur, 1979)
<i>H. melichthysi</i>	<i>Contracaecum melichthysi</i> Olsen, 1952	Olsen, 1952
<i>H. murrayense</i>	<i>Contracaecum murrayense</i> Johnston and Mawson, 1940	Johnston and Mawson, 1940
<i>H. ogocephali</i>	<i>Contracaecum ogocephali</i> Olsen, 1952	Olsen, 1952; this paper



Table 1.—Continued.

New combination	Original name	Pertinent reference(s)
<i>H. okadai</i>	<i>Contracaecum okadai</i> Fujita, 1940	Fujita, 1940
<i>H. pagrosomi</i>	<i>Contracaecum pagrosomi</i> Yamaguti, 1935	Yamaguti, 1935
<i>H. paralichthydis</i>	<i>Contracaecum paralichthydis</i> Yamaguti, 1941	Yamaguti, 1941
<i>H. rectum</i>	<i>Contracaecum rectum</i> Yamaguti, 1961	Yamaguti, 1961
<i>H. reliquens</i>	<i>Thynnascaris reliquens</i> Norris and Overstreet, 1975	Norris and Overstreet, 1975; this paper
<i>H. rhacodes</i>	<i>Thynnascaris rhacodes</i> Deardorff and Overstreet, 1979	Deardorff and Overstreet, 1978
<i>H. rigidum</i>	<i>Ascaris rigida</i> Rudolphi, 1809	Punt, 1941; Berland, 1961; Petter, 1969b; Hartwich, 1975 (considered a junior synonym of <i>C. marinum</i> by Yamaguti, 1935)
<i>H. saba</i>	<i>Contracaecum saba</i> Yamaguti, 1941	Yamaguti, 1941
<i>H. salvelini</i>	<i>Contracaecum salvelini</i> Fujita, 1940	Fujita, 1940
<i>H. scomberomori</i>	<i>Contracaecum scomberomori</i> Yamaguti, 1941	Yamaguti, 1941
<i>H. seriolae</i>	<i>Contracaecum seriolae</i> Yamaguti, 1941	Yamaguti, 1941; Brunsdon, 1956; Machida <i>et al.</i> , 1978
<i>H. trichiuri</i>	<i>Contracaecum trichiuri</i> Thwaite, 1927	Thwaite, 1927
<i>H. zenis</i>	<i>Contracaecum zenis</i> Baylis, 1929	Baylis, 1929
<i>H. zenopsis</i>	<i>Contracaecum zenopsis</i> Yamaguti, 1941	Yamaguti, 1941; Brunsdon, 1956

greatest width; ratio of greatest width to length 1:54–85. Lips 43–81 long by 43–80 wide. Esophagus 0.9–1.5 mm long or 6.4–7.8% of body length. Ventriculus 65–127 long by 50–100 wide; ventricular appendage 506–835 long by 24–38 wide; ratio for lengths of ventricular appendage to esophagus 1:1.6–1.8. Intestinal cecum 144–296 long by 43–84 wide; ratio of cecal to ventricular appendage lengths 1:2.1–3.9; ratio of cecal to esophagus lengths 1:5.0–6.5. Nerve ring located within anterior 25.5–29.4% of esophageal, 24–38 in breadth. Spicules 2.9–4.7% of body length, 560–680 long by 14–17 wide;

Table 2.—Species of uncertain status\*, but possibly referable to *Hysterothylacium* because they contain an intestinal cecum and ventricular appendage and mature in the alimentary canal of fishes.

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<i>Contracaecum filiforme</i> (Stossich, 1904)
<i>Contracaecum macquariae</i> Johnston and Mawson, 1940
<i>Contracaecum macrozarcium</i> Nigrelli, 1946
<i>Contracaecum mulli</i> (Wedl, 1855)
<i>Contracaecum naitoi</i> Fujita, 1932
<i>Contracaecum ochotense</i> Fujita, 1932
<i>Contracaecum serrani</i> Kalyankar, 1972
<i>Contracaecum synpapillus</i> Bilqees, Khanum, and Jehan, 1971

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\* See text for references to other nominal species with status more uncertain.

spicule-ratio 1:1.0. Caudal papillae 21–33 pairs, becoming closer together and more medial as approaching anus; preanal pairs 13–25; postanal pairs 8; para-anal pairs lacking. Medioventral preanal organ indistinct. Phasmids anterior and lateral to last papillar pair. Tail 129–173 long including 12–14 rounded and pointed projections measuring 9–19 long plus several shorter ones near posterior nonconical extremity.

Female (based on 5 specimens): Body 10.0–15.4 mm long by 144–189 wide at greatest width; ratio of greatest width to length 1:69–92. Lips 48–63 long by 48–63 wide. Esophagus 1.0–1.1 mm long or 7–10% of body length. Ventriculus 72–107 long by 48–86 wide; ventricular appendage 556–661 long by 24–49 wide; ratio for lengths of ventricular appendage to esophagus 1:1.5–2.1. Intestinal cecum 120–166 long by 50–60 wide; ratio of cecal to ventricular appendage lengths 1:3.4–5.4; ratio of cecal to esophageal lengths 1:6.4–8.3. Nerve ring located within anterior 22–34% of esophagus, 31–41 in breadth. Vulva without salient lips, opening 5.0–6.0 mm or 30–38% of body length from anterior extremity. Ovaries not extending beyond anterior level of vulva. Phasmids inconspicuous. Tail 247–284 long including 12–14 rounded and pointed projections measuring 7–18 long plus several shorter ones near posterior nonconical extremity.

*Hosts*.—*Scomberomorus brasiliensis* Collette, Russo, and Zavala-Camin, serra Spanish mackerel, type-host; *S. maculatus* Mitchill, Spanish mackerel; *S. cavalla* (Cuvier), king mackerel (Scombridae); *Oligoplites saurus* (Bloch and Schneider), leatherjacket (Carangidae); *Mycteroperca bonaci* (Poey), black grouper (Serranidae).

*Sites of infection*.—Stomach and intestine.

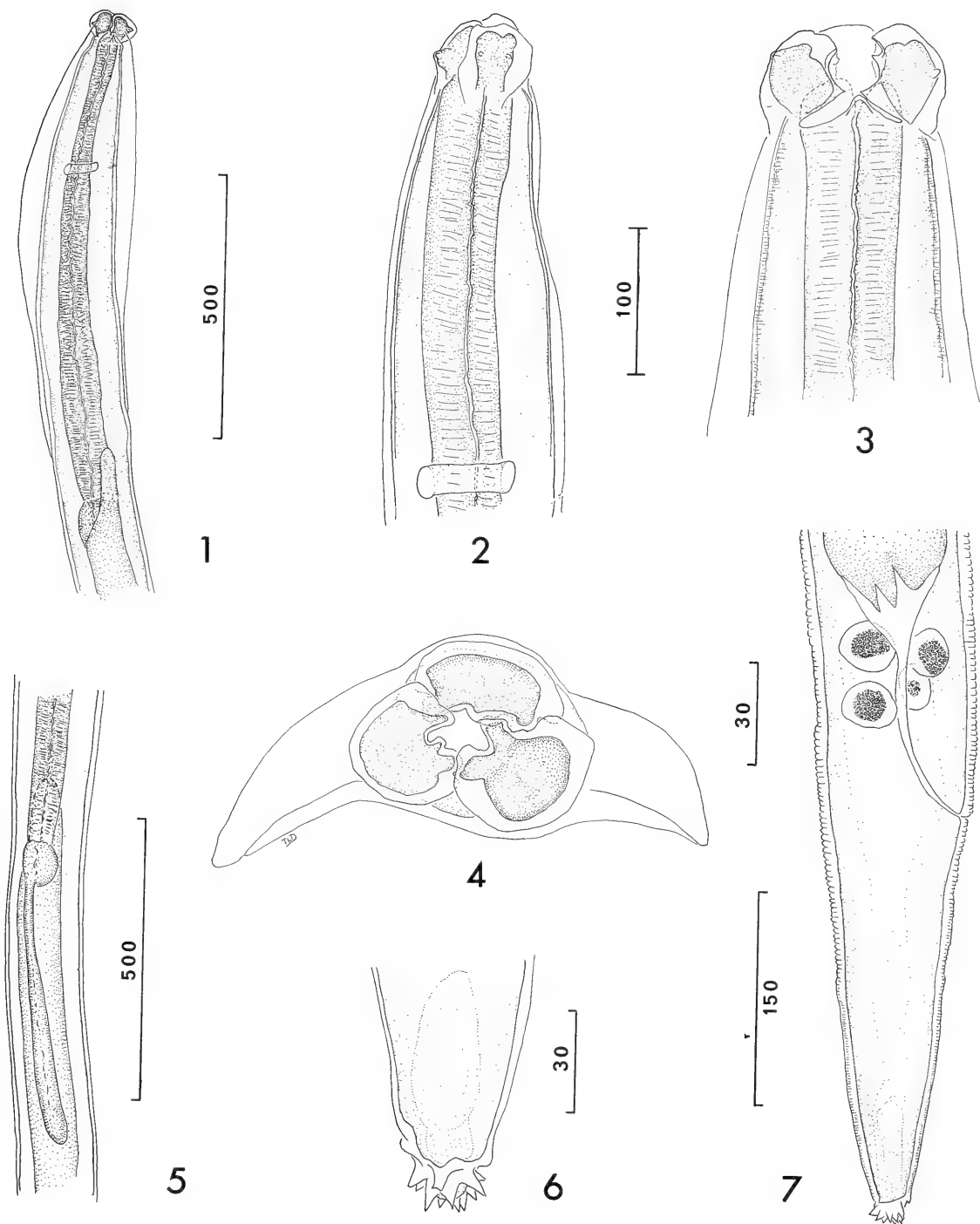
*Localities*.—Horn Island, Mississippi; Biscayne Bay, Florida; Ceará, Brazil (type-locality).

*Specimens deposited*.—USNM Helm. Coll. No. 75838 (pair); BMNH Reg. No. 1980.359–360 (pair); OCI 31.812a–b (pair).

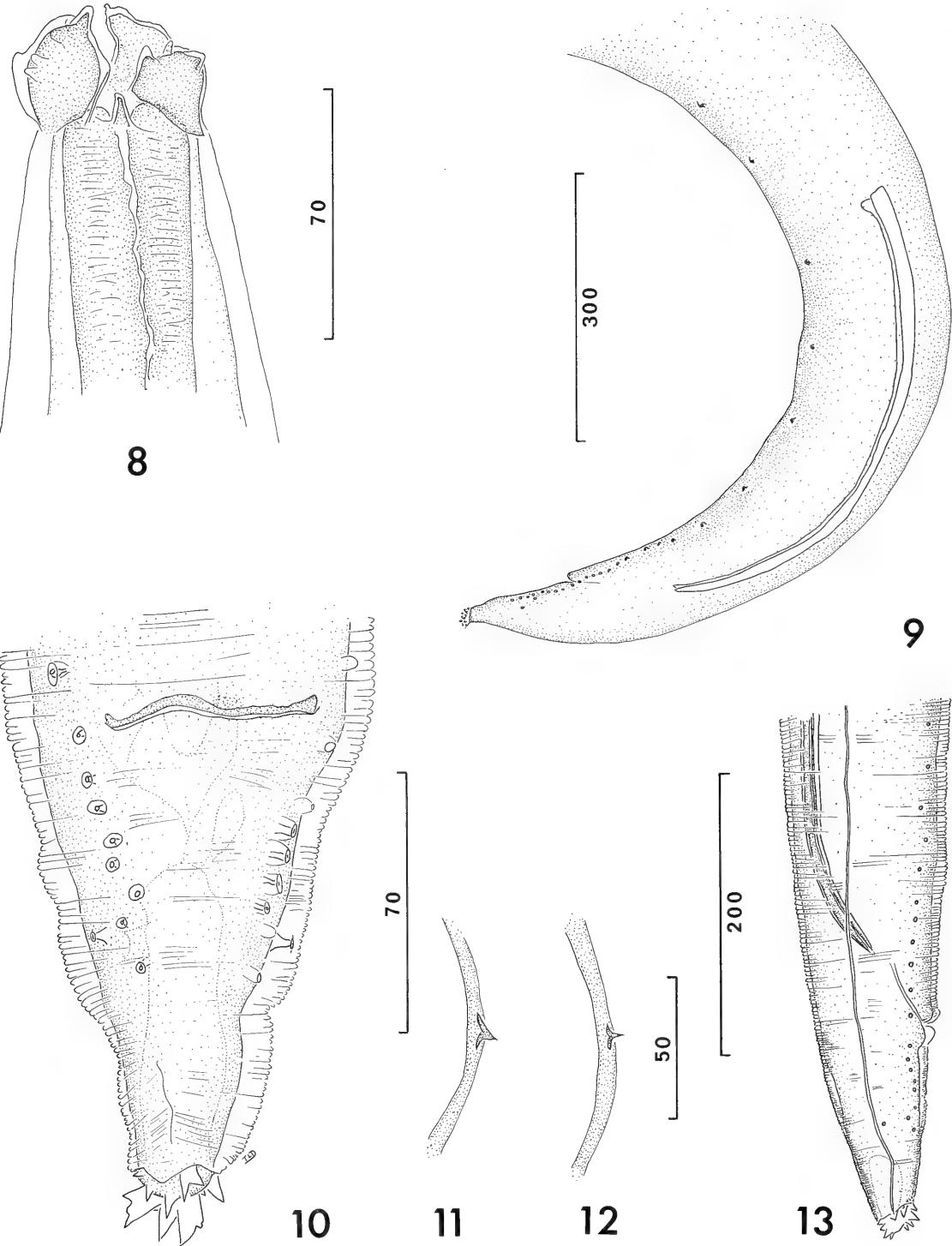
*Remarks*.—Klein (1973) collected *Hysterothylacium* (= *Contracaecum*) *fortalezae* at Ceará, Brazil, from the stomach and intestine of *Scombero-*

Table 3.—Larval ascaridoids of uncertain status, some of which probably will be shown as referable to *Hysterothylacium* and some probably will be junior synonyms.

Parasite	Remarks
<i>Contracaecum aori</i> Khan and Yaseen, 1969	In body cavity of <i>Mystus aor</i> ; excretory pore not mentioned; intestinal cecum shorter than ventricular appendage; probably fourth stage larva.
<i>Contracaecum benimasu</i> Fujita, 1932	In body cavity of <i>Oncorhynchus</i> spp.; location of excretory pore not mentioned; vagina opening to rectum (?); probably fourth stage larva.
<i>Contracaecum brevicaecum</i> Khan and Yaseen, 1969	In body cavity of "sawfish"; excretory pore slightly posterior to level of nerve ring; third stage larva.
<i>Contracaecum collieri</i> Chandler, 1935	In body cavity of <i>Cyprinodon variegatus</i> ; no excretory pore mentioned; intestinal cecum longer than ventricular appendage; third stage larva.
<i>Contracaecum hippoglossi</i> Fujita, 1932	In body cavity of several fishes; location of excretory pore not mentioned; intestinal cecum longer than ventricular appendage; vulva opens to rectum (?); probably developing fourth stage larva within third stage molt.
<i>Contracaecum hypomesi</i> Fujita, 1932	In body cavity of <i>Hypomesus</i> spp., <i>Clupea pallasii</i> , and <i>Oncorhynchus nerka</i> (as well as intestine); location of excretory pore not mentioned; intestinal cecum longer than ventricular appendage; probably fourth stage larva.
<i>Contracaecum mesopi</i> Fujita, 1940	In body cavity of <i>Mesopus olidus</i> ; excretory pore near nerve ring; males unknown; probably fourth stage larva.
<i>Contracaecum (Thynnascaris) nototheniae</i> Johnston and Mawson, 1945	Immature specimens from <i>Notothenia rossi</i> and <i>N. macrocephala</i> ; broad cervical alae of unequal length; location of excretory pore not mentioned; probably fourth stage larva.
<i>Contracaecum oshoroensis</i> Fujita, 1940	In body cavity of <i>Oncorhynchus keta</i> and <i>Mesopus olidus</i> ; excretory pore "indistinct"; fourth stage larva.
<i>Contracaecum taii</i> Fujita, 1932	In body cavity of <i>Taius tumifrons</i> ; excretory pore not mentioned; probably developing fourth stage larva.
<i>Contracaecum (Thynnascaris) tasmaniense</i> Johnston and Mawson, 1945	Site of infection not mentioned; from <i>Notopogon liliei</i> and <i>Coclorhynchus australis</i> ; location of excretory pore not mentioned; intestinal cecum longer than ventricular appendage; fourth stage larva.
<i>Contracaecum vittatii</i> Khan and Begum, 1971	In body cavity of <i>Upeneus vittatus</i> ; excretory pore near nerve ring; third stage larva.



Figs. 1–7. *Hysterothylacium fortalezae*: 1, Anterior end showing lateral alae and spacial relationship between excretory pore and nerve ring; 2, Dorsal view of lips; 3, Ventral view of lips showing interlabium; 4, *En face* showing lateral alae; 5, Body at level of intestinal-ventricular junction, lateral view; 6, Posterior extremity of female tail showing tuft of projections, lateral view; 7, Female tail, lateral view.



Figs. 8–13. *Hysterothylacium fortalezae*: 8, Ventral view of lips (paratype No. OCI 30.810c); 9, Posterior end of male paratype showing caudal papillae, lateral view; 10, Posterior end of male showing post- and para-anal papillae, ventral view; 11, Lateral ala at esophageal-ventricular junction; 12, Lateral ala immediately anterior to anus (scale same for Figs. 11, 12); 13, Posterior end of male from Florida showing caudal papillae, lateral view.

*morus cavalla* and the type-host, *S. brasiliensis* (as *S. maculatus*) (Vicente, personal communication). Although most characteristics reported by Klein are comparable to those of our specimens collected from *S. maculatus* and *Oligoplites saurus* in the northern Gulf of Mexico and Biscayne Bay, Florida, discrepancies exist among her description, figures, and a paratype (OCI 30.810c) loaned by Vicente. She reported 21 pairs of caudal papillae made up of 5 preanal, 11 postanal, and 5 para-anal papillae. However, the paratype we examined, which was stained and permanently mounted on a slide, possessed 28 pairs of caudal papillae: 18 preanal, 8 postanal, and no para-anal (Fig. 9). Additionally, the cloacal opening was incorrectly located in the illustration, leading to difficulty assessing the papillae. Klein noted the prominent cervical alae, but did not include them in the *en face* illustration.

*Hysterothylacium fortalezae* and *H. chaunaxi* (Olsen, 1952) are distinguished from all other members of the genus in the Gulf of Mexico by having a tuft of projections at their posterior extremity rather than dense, evenly distributed spines on a conical tip; most of these projections were rounder on *H. chaunaxi*. What appears to be similar projections are illustrated for other species including specimens identified by Zhukov (1960) as *C. fabri* from *Scomber japonicus* (as *Pneumatophorus japonicus*), also a mackerel, from Putyatín Island, USSR. Those latter specimens and the status of *C. fabri* need further investigation. The conspicuous cervical alae on *H. fortalezae* separates it from *H. chaunaxi*. Those alae also occur on *H. aduncum* as shown by Punt (1941), *H. trichiuri*, and specimens identified as *H. clavatum* by Kreis (1952) and as *H. histiophori* by Olsen (1952). They may occur also on other species.

*Hysterothylacium ogcocephali* (Olsen), new combination

Figs. 14–21

*Contracaecum ogcocephali* Olsen, 1952:177–178, pl. I, figs. 12–17 (original description; type-host *Ogcocephalus radiatus*; type-locality Tortugas, Florida).

*Thynnascaris ogcocephali*.—Norris and Overstreet, 1975:333 (new combination).

*Diagnosis*.—Cuticle without conspicuous annulations; lips with ratio of length to width 1:0.5–0.7, with flanges indented at anterior  $\frac{1}{3}$  of lip; caudal papillar pairs: preanal 28–31, postanal 3–4 with 3rd or 4th papilla from posterior extremity doubled; spicules 1–2% of body length; spicule ratio 1:0.8–1.3; tail with short digitiform process lacking ornamentation on posterior extremity.

*General*.—Body reaching greatest width near midbody. Cuticle with inconspicuous annulations; lateral alae distinct on each side, becoming more apparent at levels posterior to rectum; supports nearly flat anteriorly and

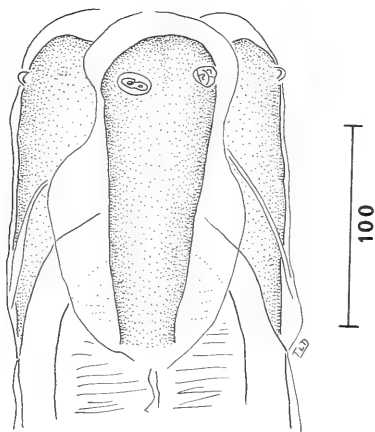
near midbody, with slight V-shape (in cross-section) in tail but not reaching external surface of cuticle. Lips approximately equal in size, 1.4–1.8 times longer than wide; flanges constricted at anterior  $\frac{1}{3}$  of lip; pulp narrowest at base, gradually becoming wider anteriorly. Interlabia with height equal to or slightly greater than width at base; interlabial grooves lacking. Esophagus 10–12% of body length. Ventriculus narrower than widest level of esophagus, nearly spherical; ventricular appendage descending without angulation from posterior portion of ventriculus. Nerve ring located at anterior 10–14% of esophagus. Excretory pore immediately posterior to level of nerve ring. Tail with short digitiform process; process lacking spines.

Male (based on 10 mature specimens for most characters and 5 tail mounts for postanal papillae): Body 25.5–33.5 mm long by 0.4–0.6 mm at greatest width; ratio of greatest width to length 1:49–60. Lips 180–236 long by 103–139 wide. Nerve ring 482–593 from anterior extremity, 24–41 in breadth. Esophagus 2.6–4.0 mm long by 166–216 wide. Ventriculus 108–166 long by 129–185 wide; ventricular appendage 0.9–1.5 mm long by 49–111 wide; ratio for lengths of ventricular appendage to esophagus 1:2.4–3.2. Intestinal cecum 185–309 long by 74–148 wide; ratio of cecal to ventricular appendage lengths 1:3.3–7.3; ratio of cecal to esophageal lengths 1:9.1–18.5. Spicules 1–2% of body length, unequal; left spicule 330–500 long by 19–28 wide; right spicule 350–660 long by 19–28 wide, longer than left spicule in 5 specimens; spicule ratio 1:0.8–1.3. Caudal papillae 31–34 pairs; preanal papillae pairs 28–31, with posteriormost one on right side doubled on one specimen; postanal pairs 3, except 4 papillae on right side and 3 on left of one specimen; with 3rd papilla from posterior extremity doubled except for one specimen on which left 2nd papilla doubled; para-anal papillae lacking. Medioventral preanal organ papillated, simple, at middle of preanal fold, single, directed posteriorly. Tail flexed ventrad, 139–185.

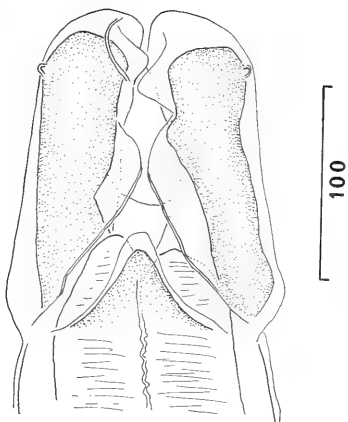
Female (based on 10 mature specimens): Body 25.6–48.1 mm long by 0.6–1.0 mm wide; ratio of greatest width to length 1:41–61. Lips 168–309 long by 130–166 wide. Nerve ring 552–704 from anterior extremity, 30–55 in breadth. Esophagus 3.1–5.3 mm long by 234–339 wide. Ventriculus 154–247 long by 185–241 wide; ventricular appendage 0.8–1.4 mm long by 74–123 wide; ratio for lengths of ventricular appendage to esophagus 1:2.8–4.7. Intestinal cecum 185–444 long by 123–247 wide; ratio of cecal to ventricular

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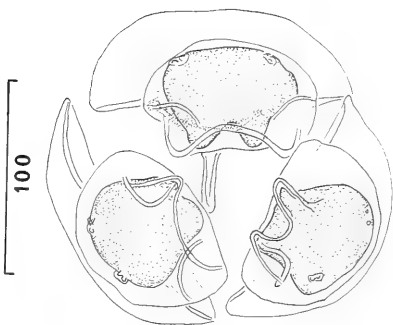
Figs. 14–21. *Hysterothylacium ogcocephali*: 14, Dorsal view of lips; 15, Ventral view of lips showing interlabium; 16, *En face*; 17, Body at level of intestinal-ventricular junction, lateral view; 18, Posterior extremity of female tail, lateral view; 19, Posterior end of female tail, lateral view; 20, Posterior end of male showing caudal papillae, lateral view; 21, Posterior end of male showing postanal papillae with atypical double second papilla on left side, ventral view.



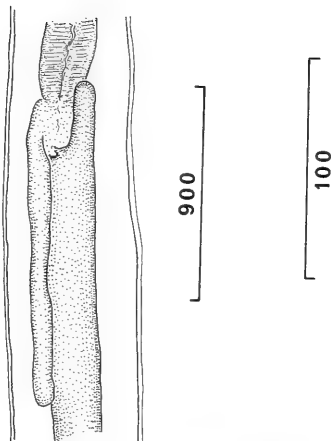
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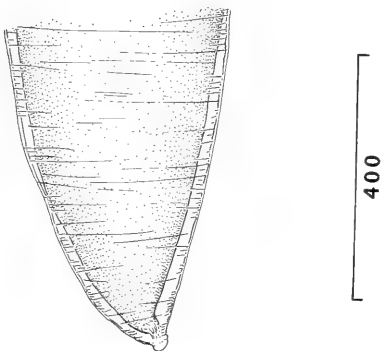
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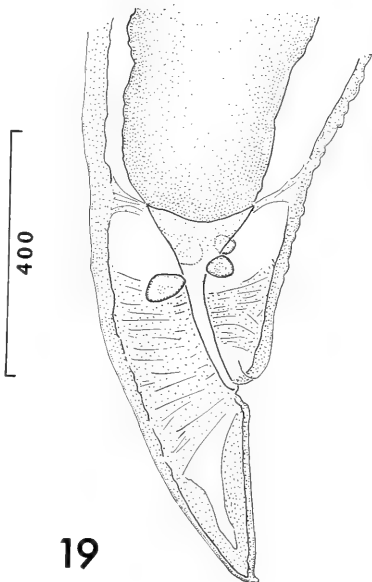
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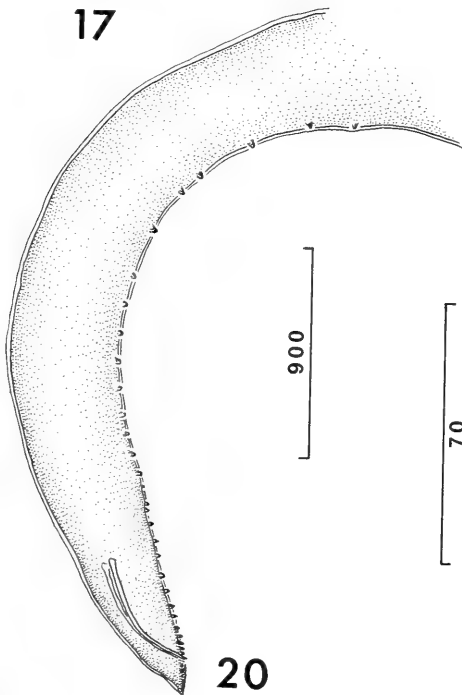
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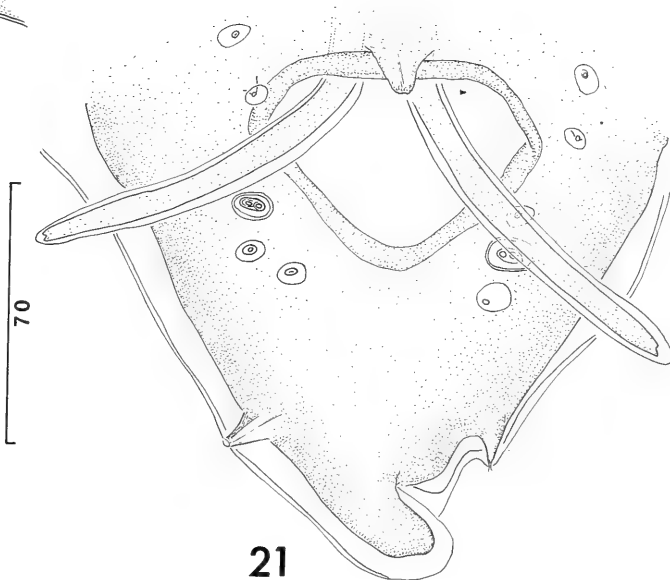
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appendage lengths 1:2.7–5.0; ratio of cecal to esophageal lengths 1:11–17. Vulva without salient lips, opening 9–13 mm or 24–40% of body length from anterior extremity. Ovaries rarely extending beyond anterior level of vulva. Eggs 30–55 in diameter. Tail 472–587 long including minute process.

*Hosts*.—*Ogcocephalus radiatus* (Mitchill), polka-dot batfish GCRL 7002, *O. cubifrons* (Richardson) (Ogcocephalidae).

*Site of infection*.—Stomach and upper intestine.

*Localities*.—Biscayne Bay, Tortugas, and Lee County (26°52'00"N, 82°18'35"W), Florida.

*Specimens deposited*.—USNM Helm. Coll. No. 75839 (pair); BMNH Reg. No. 1980.361–362 (pair); OCI 31.604.

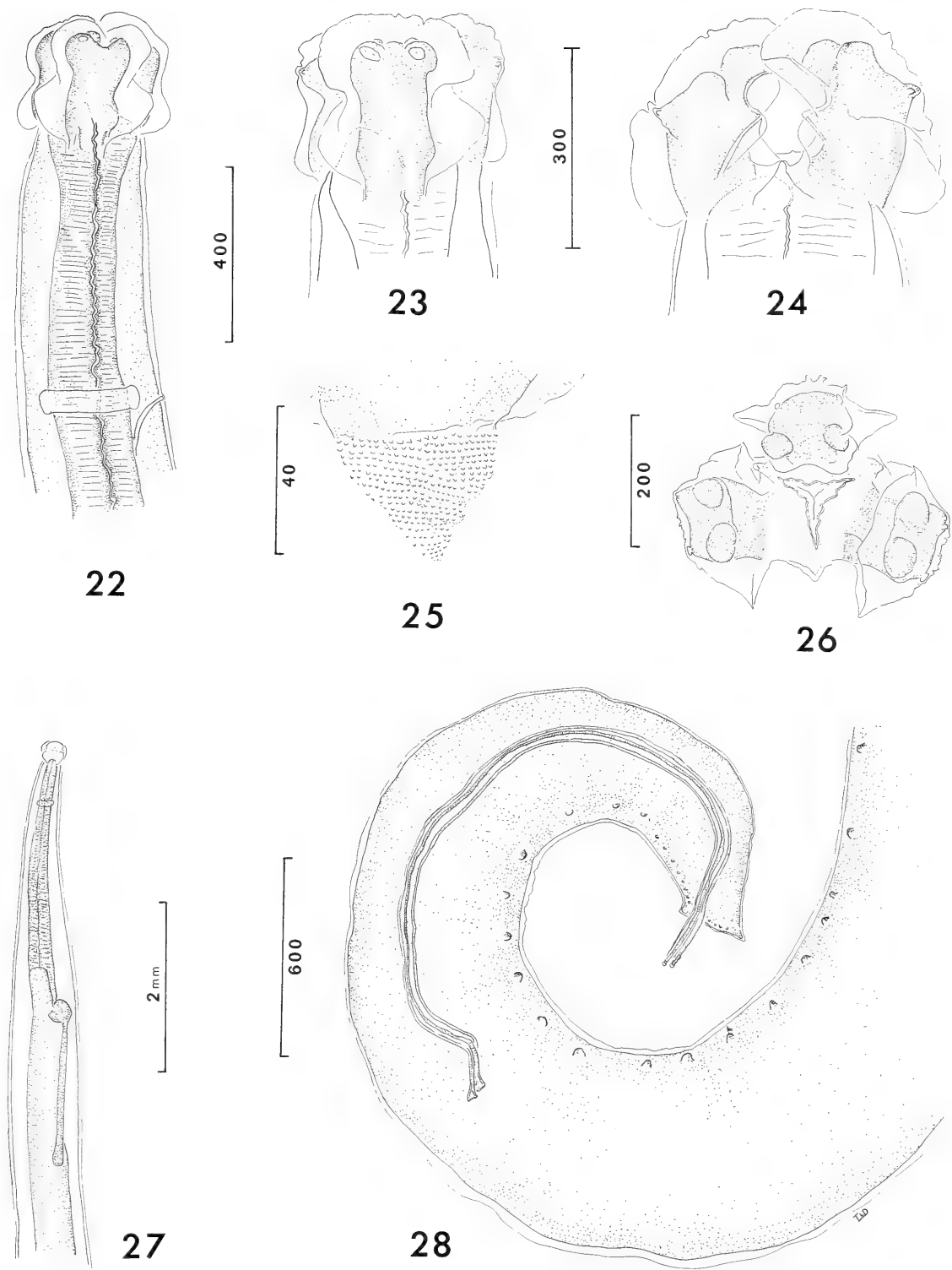
*Remarks*.—Our report is the second for *H. ogcocephali*. Olsen (1952) originally described it from *Ogcocephalus radiatus* using data and figures from an unpublished thesis by B. Rees with most measurements given for one male and one female. Consequently, his description did not provide morphological variation among individuals. Additionally, Olsen did not treat some specific characters, and some differed from what we found. He reported 18–26 pairs of preanal papillae and 1–2 pairs of para-anal ones, whereas we counted a total of 31–34 pairs including the 3 postanal ones. We examined the holotype (USNM No. 37241) and confirmed that the lateral cephalic flanges had indentations near the anterior  $\frac{1}{3}$  similar to those for *Iheringascaris iniquus*. The holotype's poor condition, however, resulted in many features being obscured. The terminal end of the tail lacked a multispinous structure (Fig. 21); a structure present on all species with similar lip morphology. This multispinous structure may prove to be a valuable diagnostic character in ascaridoid nematodes and should be noted when present.

*Hysterothylacium reliquens* (Norris and Overstreet), new combination  
Figs. 22–39

*T. reliquens* Norris and Overstreet, 1975:330–332, figs. 1–11 (original description; type-host *Archosargus probatocephalus*; type-locality Mississippi Sound, Mississippi).

*Diagnosis*.—Cuticle without conspicuous annulations; lips with ratio of length to width 1:0.6–1.0, with flanges indented equatorially; caudal papillar pairs: preanal 23–29, postanal 4–5 with 3rd pair from posterior extremity doubled; spicules 3–8% of body length; spicule-ratio 1:0.6–1.3; multispinous conical process on posterior extremity.

*General* (based on specimens from *Ogcocephalus cubifrons*).—Body reaching greatest width near midbody. Cuticle with inconspicuous annulations and minute lateral alae; alae becoming more apparent at levels posterior to rectum. Lips approximately equal in size, all longer than wide;



Figs. 22–28. *Hysterothylacium reliquens*: 22, Anterior end showing spacial relationship between excretory pore and nerve ring; 23, Dorsal view of lips; 24, Ventral view of lips showing interlabium; 25, Multispinous process on female tail, lateral view; 26, *En face*; 27, Body at level of intestinal-ventricular junction, lateral view; 28, Posterior end of male showing caudal papillae, lateral view.

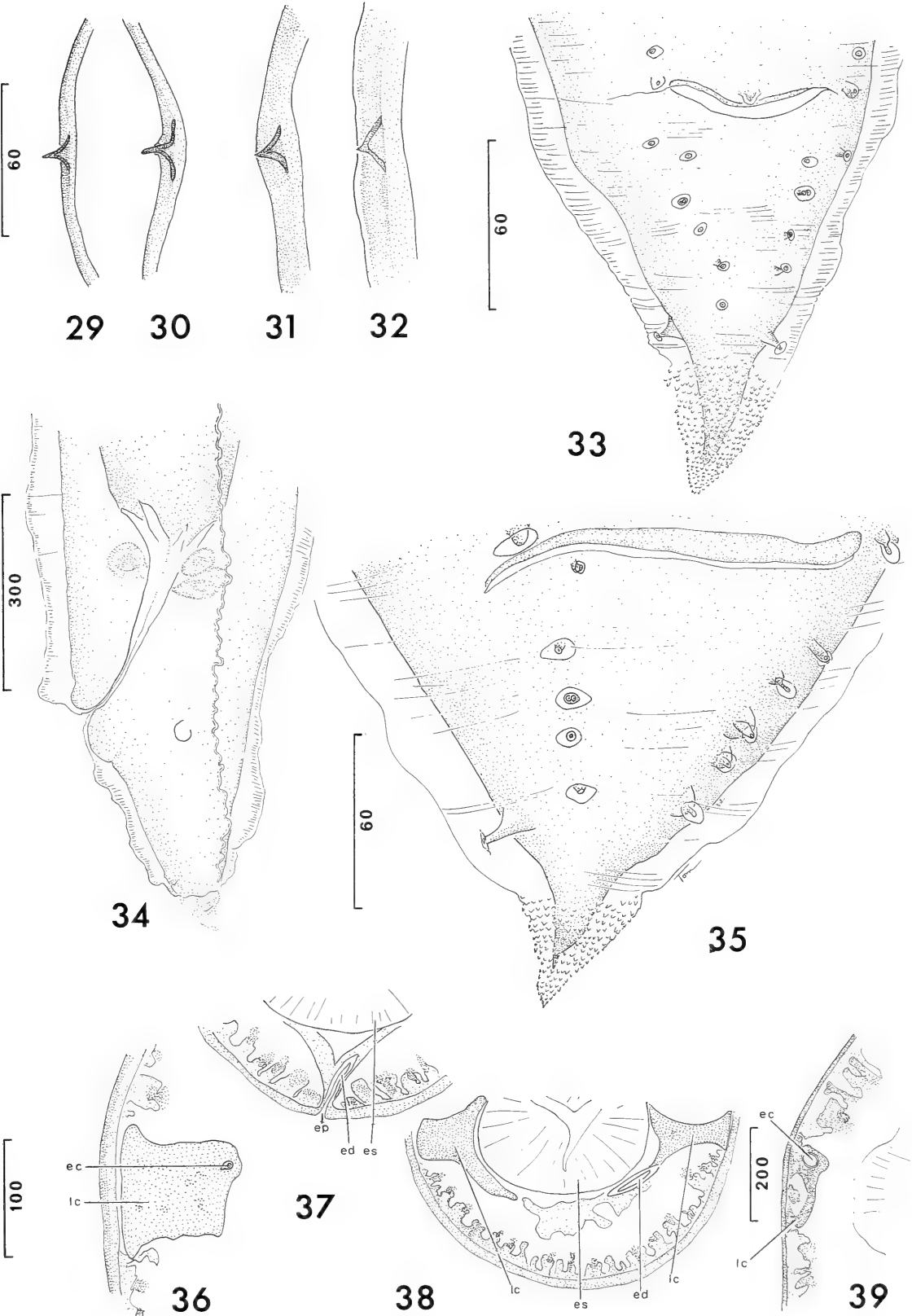
flanges constricted near middle of lip; pulp pedunculated. Interlabia with height equal to or slightly greater than width at base; interlabial grooves lacking. Esophagus 11–13% of body length. Ventriculus narrower than widest level of esophagus, usually longer than broad; ventricular appendage departing without angulation from posterior portion of ventriculus. Nerve ring located at anterior 16–28% of esophagus. Excretory pore at or immediately posterior to level of nerve ring; excretory system with duct extending posteromesial from pore toward esophagus before entering left lateral cord as lateral canal; lateral (=longitudinal) canal gradually increasing in diameter until termination within tail. Tail with spined conical mucronate extremity.

Male (based on 11 mature specimens, but 9 tail mounts for postanal papillae): Body 25–40 mm long by 0.5–0.9 mm at greatest width; ratio of greatest width to length 1:30–57. Lips 234–291 long by 234–285 wide. Nerve ring 646–977 from anterior extremity, 49–69 in breadth. Esophagus 3.3–4.5 mm long by 150–230 wide. Ventriculus 141–300 long by 110–236 wide; ventricular appendage 1.2–1.7 mm long by 80–130 wide; ratio for lengths of ventricular appendage to esophagus 1:2.5–2.8. Intestinal cecum 315–598 long by 260–310 wide; ratio of cecal to ventricular appendage lengths 1:2.2–3.5; ratio of cecal to esophageal lengths 1:7–10. Spicules 3–8% of body length, 1.7–2.4 mm long by 9–20 wide; right spicule longer than left one in 5, equal in 5, and shorter in 1 specimen; spicule-ratio 1:0.6–1.3. Caudal papillae 27–33 pairs, becoming closer together and more medial as approaching anus; preanal pairs 23–29; postanal pairs 4–5, with 3rd pair from posterior extremity doubled; para-anal papillae lacking. Medioventral pre-anal organ distinct, papillated. Tail flexed ventrad, 123–185 long including a multispinous process 12–46 long.

Female (based on 18 mature specimens): Body 21–44 mm long by 0.5–1.1 mm wide; ratio of greatest width to length 1:33–58. Lips 222–340 long by 204–309 wide. Nerve ring 646–977 from anterior extremity, 21–57 in breadth. Esophagus 2.9–5.0 mm long by 180–280 wide. Ventriculus 142–286 long by 126–331 wide; ventricular appendage 1.0–2.9 mm long by 95–140 wide; ratio for lengths of ventricular appendage to esophagus 1:1.7–3.0.

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Figs. 29–39. *Hysterothylacium reliquens* from *Batrachoides surinamensis* (29, 30, 31), *Ogcocephalus cubifrons* (33), and *Archosargus probatocephalus* (32, 34–39). Lateral ala at anterior (29), middle (30), and posterior (31) parts of male. 32, Lateral ala at level of base of esophagus equivalent to region in Fig. 29 (scale applies to all figures to its left); 33, Posterior end of male showing postanal papillae, ventral view; 34, Female tail, lateral view; 35, Posterior end of male showing postanal papillae, ventral view; 36–39, Cross-sections of excretory system showing excretory canal anterior to nerve ring (36), excretory pore (37), excretory duct (37–38), and excretory canal at esophageal-ventricular junction (39). Abbreviations: ec = excretory canal, ed = excretory duct, ep = excretory pore, es = esophagus, lc = lateral cord.



Intestinal cecum 394–788 long by 265–322 wide; ratio of cecal to appendage lengths 1:1.6–5.2; ratio of cecal to esophageal lengths 1:5–8. Vulva without salient lips, opening 6.5–17.0 mm or 16–45% of body length from anterior extremity. Ovaries rarely extending beyond anterior level of vulva. Tail 370–574 long including multispinous process 12–60 long.

*Hosts*.—*Archosargus probatocephalus* (Walbaum), sheepshead (Sparidae) type-host; *Opsanus beta* (Goode and Bean), Gulf toadfish, *Batrachoides surinamensis* (Bloch and Schneider), *B. pacifici* (Günther), *B. boulengeri* Gilbert and Starks, and *Batrachoides* sp. (new species from El Salvador and the Pacific coast of Mexico being described by Collette and Russo, in press) (Batrachoididae); *Ogcocephalus cubifrons* (Richardson), *Ogcocephalus pantostictus* Bradbury, (GCRL 564) (Ogcocephalidae); *Arius felis* (Linnaeus), sea catfish (Ariidae); *Chilomycterus schoepfi* (Walbaum), striped burrfish (Diodontidae); *Micropogonias undulatus* (Linnaeus), Atlantic croaker, *Sciaenops ocellata* (Linnaeus), red drum (Sciaenidae); *Gymnothorax nigromarginatus* (Girard), blackedge moray (Muraenidae).

*Sites of infection*.—Stomach and intestine.

*Localities*.—Mississippi Sound, Mississippi (*Archosargus probatocephalus*, *Chilomycterus schoepfi*, and *Micropogonias undulatus*); offshore in northern Gulf of Mexico (*Sciaenops ocellata*, 30°10'N, 87°45'W, 11 meters; *M. undulatus* and *Gymnothorax nigromarginatus*, 29°33'N, 88°25'W, 46 meters; *C. schoepfi* and *A. probatocephalus*, 29°58'–59'N, 88°44'W, 15 meters; *Ogcocephalus* sp., offshore from Horn Island); Galveston, Texas (*Arius felis*); Biscayne Bay, Florida (*Opsanus beta*); Miami, Florida (*Ogcocephalus cubifrons*); Honduras, Guyana, and northern Brazil at 4°48'N, 51°19'W (*Batrachoides surinamensis*, TABL 104319, 104839, USNM 219457); Panamá (Miraflores Locks, San Francisco Beach, and 8°60'N, 79°31'W) and Colombia (*B. pacifici*, USNM 111862, 111865, UMML 26705, USNM 219385, *B. boulengeri*, GCRL 8402); and El Salvador (Bahia de Jiquilisco) and Mexico (Gulf of Tehuantepec) (*Batrachoides* sp. being described by Collette and Russo, in press, USNM 219788, SIO 63-517).

*Specimens deposited*.—from *Ogcocephalus cubifrons* (2 males and females) USNM Helm. Coll. No. 75840; from *Batrachoides surinamensis* (6 specimens) USNM Helm. Coll. No. 75498; from *Ogcocephalus pantostictus* (6 specimens) USNM Helm. Coll. No. 75841.

*Remarks*.—In addition to adding new host and locality records to those provided by Norris and Overstreet (1975), we present and discuss minor morphological variations among specimens from several hosts and provide descriptive data from specimens from a batfish for comparisons with descriptions of other species.

Worms from all hosts are similar, but we note minor differences in features such as postanal papillae. Norris and Overstreet (1975) reported 4–6

pairs of postanal papillae for *H. reliquens* from *Archosargus probatocephalus*. We examined 14 ventral tail mounts of the same and additional specimens from *A. probatocephalus* from Mississippi Sound and also counted 4–6 pairs; however, all but three males had uneven postanal papillar patterns. Six worms had 5 papillae on the right side and 4 on the left, and four worms had 6 on the right and 5 on the left. Additionally, the presence of doubled papillae was not originally noted. The fourth postanal papilla on the right side and third on the left from the posterior extremity of the worm exhibited this doubled condition. Of those worms with paired postanal papillae, one worm had 5 pairs with the fourth papilla doubled and two worms had 4 pairs with the third papilla doubled.

Papillae on three males from the sea catfish were like those from the batfish with 4 or 5 even pairs. Either the third or fourth pair from the worm's posterior end was doubled. However, the sclerotized supports of the lateral alae protruded beyond the cuticle, especially at the esophageal level.

Numerous worms were examined from several species of *Batrachoides* collected from Atlantic coasts of South America, the Panama Canal, and Colombia to Mexico in the Pacific Ocean. The papillae and alae extension (Figs. 29–31) agreed with those of catfish specimens indicated above. Specimens from *Opsanus beta*, also a batrachoidid, from Biscayne Bay, Florida, were the same, suggesting that the feature may be either host- or temperature-induced, since the worms in most other fishes as represented by the sheepshead, or type-host, in the northern Gulf of Mexico appeared to have indistinct alae by comparison (Fig. 32).

The presence of *H. reliquens* in the Pacific Ocean is unusual because few, if any, other ascaridoids in nonpelagic fishes occur in both the Atlantic and Pacific oceans. *Hysterothylacium aduncum*, considered a junior synonym of *H. gadi* by Hartwich (1975) and others, has been reported from the Pacific, but specimens reported from both oceans need critical examination.

*Hysterothylacium reliquens* heavily infects different hosts in different regions. As examples, heavy infections occurred in *Ogcocephalus cubifrons* from Miami, Florida, *Archosargus probatocephalus* from Mississippi, *Arius felis* from Galveston Bay, Texas, and *Batrachoides surinamensis* from northern Brazil. Collette and Russo (in press) revised the genus *Batrachoides* and examined a few intestines of each of the nine species, finding *H. reliquens* in four species. *Batrachoides manglae* Cervigón from hypersaline regions of Venezuela and *B. goldmani* Evermann and Goldsborough from freshwater streams in Mexico and Guatemala were two species that did not harbor *H. reliquens*. We speculate that fish acquire *H. reliquens* in relatively high-salinity regions or from intermediate hosts that recently inhabited such regions based on 1) infections in batrachoidids restricted to locations with salinities above 20 ppt but not hypersaline; 2) heavy infections in some fishes caught offshore or in high-salinity habitats; 3) large numbers

of noninfected susceptible fishes in relatively low-salinity water of Mississippi Sound and elsewhere; and 4) findings in some infected fish from relatively low salinities of Mississippi Sound of additional concurrent helminths that depend on high-salinity habitats to complete their cycles. Infections also relate to food habits and perhaps to physiological races of worms. In any event, we neither encountered infected *A. felis* in Mississippi Sound nor encountered or heard about conspicuously infected sheepshead in Texas (including Galveston Bay) from numerous Texas sources. Specimens of *Chilomycterus schoepfi* and *Micropogonias undulatus* occasionally had infections in Mississippi Sound or near the barrier islands, but never heavy ones like in individual sheepshead which often harbored more than 350 worms, half of which were mature and many of which exited the host following removal of the fish from water. Other than the single Atlantic croaker (*M. undulatus*) listed from 46 meters deep off the Chandeleur Islands in 1973, we did not collect any other specimens of *H. reliquens* from offshore croaker. Between 1974 and 1977, we examined 1,700 croaker collected by the R/V OREGON II and GEORGE M. BOWERS from 42 stations with depths ranging from 11–90 meters and did not find *H. reliquens*.

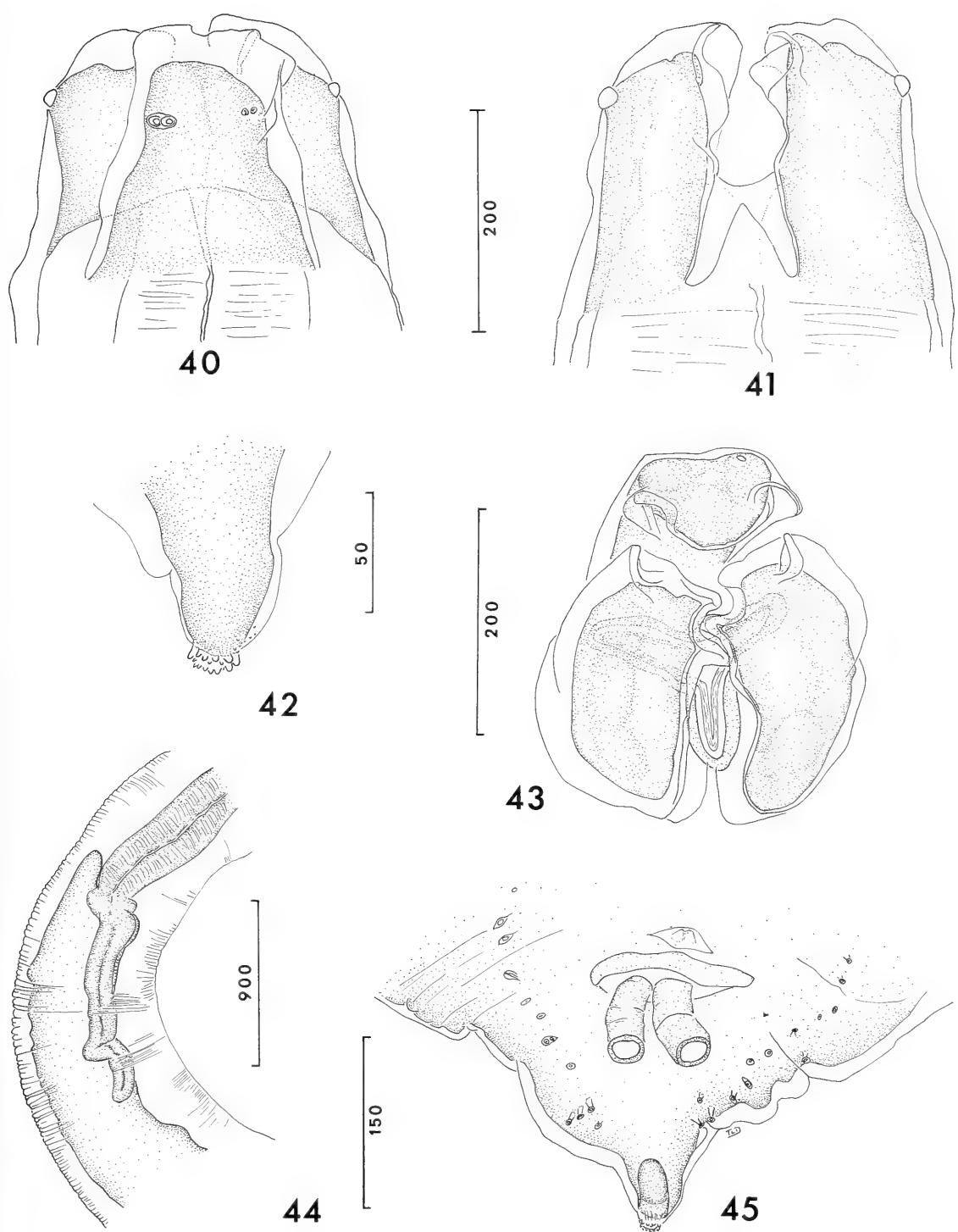
Four species of *Hysterothylacium*, *H. reliquens* and *H. ogcocephali* from the Gulf of Mexico, *H. melichthysi* from the Hawaiian Islands, and *H. rhacodes* from the eastern Mediterranean Sea, have the diagnostically elongated lips. The lips contain elongated pulp bordered by distinctly indented lateral flanges. Other species also have indented flanges, but not in conjunction with elongated lips. Flanges on *H. reliquens* are indented equatorially, whereas the position on those of *H. ogcocephali* and *H. melichthysi* occurs about  $\frac{1}{3}$  of the length from the anterior end. *Hysterothylacium rhacodes* has similar flanges to *H. reliquens*, but does not have any doubled postanal papillae.

*Hysterothylacium chaunaxi* (Olsen), new combination  
Figs. 40–45

*Contracaecum chaunaxi* Olsen, 1952:178, pl. II, figs. 18–22 (original description; type-host *Chaunax* sp.; type-locality Tortugas, Florida).

*Diagnosis*.—Cuticle without conspicuous annulations; lips with ratio of length to width 1:0.8, with pulp not pedunculate; caudal papillar pairs: preanal 23, postanal 7 with doubled papilla 6th from posterior extremity on right side; tuft of projections at posterior extremity.

*General*.—Body reaching greatest width near midbody. Cuticle with inconspicuous annulations. Lips approximately equal in size; pulp not pedunculate, widest at base. Interlabia with width at base equal to or slightly greater than height; interlabial grooves lacking. Ventriculus narrower than widest level of esophagus, usually longer than wide; ventricular appendage



Figs. 40–45. *Hysterothylacium chaunaxi*: 40, Dorsal view of lips; 41, Ventral view of lips showing interlabium; 42, Posterior extremity of female tail showing terminal tuft with projections, lateral view; 43, *En face*; 44, Body at level of intestinal-ventricular junction, lateral view; 45, Posterior end of male showing postanal papillae, ventral view; note broken spicules.



descending without angulation from posterior portion of ventriculus. Excretory pore just posterior to level of nerve ring. Tail with tuft of rounded and pointed projections at posterior extremity.

Male (based on 1 specimen plus holotype USNM Helm. Coll. No. 37243 with its measurements in parentheses): Body 34.7 (39.5) mm long by 947 (709) at greatest width; ratio of greatest width to length 1:36 (1:56). Lips 253 (120) long. Esophagus 2.8 (3.3) mm long by 333 wide or 8 (8)% of body length. Ventriculus 284 (259) long by 174 (279) wide; ventricular appendage 1.2 mm long (not visible) by 173 wide; ratio for lengths of ventricular appendage to esophagus 1:2.3. Intestinal cecum 819 (1.0 mm) long by 488 (247) wide; ratio of cecal to ventricular appendage lengths 1:1.4; ratio of cecal to esophagus lengths 1:3.4 (1:3.3). Nerve ring located within anterior 26% of esophagus, 50 in breadth. Excretory pore immediately below posterior level of nerve ring. Spicules broken at cloaca, 1.5 mm long by 31 wide. Caudal papillae 30 pairs (not able to count), becoming closer together and more medial as approaching anus; preanal pairs 23; postanal pairs 7, doubled papilla 5th from posterior extremity on right side only; para-anal papillae lacking. Medioventral preanal organ distinct, papillated. Tail 185 (203) long including tuft with projections up to 12 long on posterior extremity.

*Host*.—*Chaunax pictus* Lowe (Chaunacidae) GCRL 679.

*Site of infection*.—Intestine.

*Localities*.—Tortugas, Florida (type-locality) and 29°13'N, 87°55.5'W (460 meters) R/V OREGON Station No. 3680.

*Specimen deposited*.—USNM Helm. Coll. No. 75842, body-fragments in vial plus *en face* and tail mounted in glycerin jelly on separate slides.

*Remarks*.—Olsen (1952) noted the tuft on the tail of *H. chaunaxi*, although he did not illustrate it. On the basis of this distinct structure at the posterior extremity (Figs. 42, 45), *H. chaunaxi* and *H. fortalezae* differ from all other examined members of the genus. *Hysterothylacium chaunaxi* can be distinguished from *H. fortalezae* by body length, ratio of greatest width to length, ratio of cecal to ventricular appendage lengths, and number and arrangement of pre- and postanal papillae. Additionally, *H. chaunaxi* lacks conspicuous anterior cervical alae.

One of five, fixed, museum specimens of *Chaunax pictus* collected from the same locality in the Gulf of Mexico harbored the single male *H. chaunaxi*. Olsen described *H. chaunaxi* from *Chaunax* sp. at Tortugas, Florida, also from a single male. The holotype is rather opaque; consequently, we do not include data on all its features above. The type-host is presumably *C. pictus*. No other records of an infection exist.

*Hysterothylacium incurvum* (Rudolphi), new combination

Figs. 46–56

*Ascaris incurva* Rudolphi, 1819:51, 292–293 (original description; type-host *Xiphias gladius*; type-locality Baltic Sea).

*Contracaecum incurvum*.—Baylis and Daubney, 1922:282–284, figs. 17–18 (new combination).

*Contracaecum (Thynnascaris) incurvum*.—Dollfus, 1935:89–90 (new combination).

*Thynnascaris incurva*.—Hartwich, 1957:240 (new combination).

*Diagnosis*.—Cuticle with enlarged and modified annules on ventral surface of male near cloaca; alae bifurcated at tips; lips with ratio of length to width 1:1.0–1.6, with pulp deeply constricted at base, with interlabial grooves deep; caudal papillar pairs: preanal 27–28, postanal 4, para-anal 1, doubled; spicules 12–25% of body length; spicule-ratio 1:0.9–1.0; tail gradually tapering, lacking ornamentation on posterior extremity (note exception below).

*General (based on specimens from Florida)*.—Body reaching greatest width near midbody. Cuticle with inconspicuous annulations except those enlarged and modified on ventral surface of male near cloaca. Lateral alae bifurcate at tips throughout worm; supports in cross-section nearly meeting before diverging, typically external to cuticle; cervical alae not flaring. Lips approximately equal in size, all broader than long; flanges widest near base, indented at anterior  $\frac{1}{3}$  of lip. Pulp conspicuously narrow near base. Interlabia with height 2 times greater than width at base, with rounded tips; interlabial grooves deep; adjacent grooves nearly merging at base of each lip. Esophagus clavate, 7–16% of body length. Ventriculus narrower than widest level of esophagus, generally longer than broad. Nerve ring located between anterior 7–19% of esophagus. Excretory pore immediately posterior to level of nerve ring. Tail gradually tapering.

Male (based on 11 mature specimens): Body 17–34 mm long by 606–772 at greatest width; ratio of greatest width to length 1:29–49. Lips 86–154 long by 108–212 wide. Nerve ring 376–593 from anterior extremity, 33–55 in breadth. Esophagus 2.3–5.2 mm long by 92–166 wide. Ventriculus 117–166 long by 129–216 wide; ventricular appendage 1.7–2.6 mm long by 61–195 wide; ratio for lengths of ventricular appendage to esophagus 1:1–3. Intestinal cecum 1.9–4.5 mm long by 166–233 wide; ratio of lengths of cecum to ventricular appendage 1:0.4–1.0; ratio for lengths of cecal to esophageal length 1:1.0–1.5. Spicules 12–25% of body length, 2.6–8.7 mm long by 9–18 wide, equal in 8 specimens; left spicule longer in 2 specimens; spicule-ratio 1:0.9–1.0. Caudal papillae 31–32 pairs, becoming closer and more medial as approaching anus; preanal pairs 27–28; postanal pairs 4; para-anal papilla 1, doubled. Medioventral preanal organ distinct, papillated. Tail flexed ventrad, 79–197 long, without ornamentation. Modified annules on ventral surface beginning near anus, extending anteriorly 2.0–6.1 mm or 10–18% of body length; each annule with 45–57 minute longitudinal supports; supports similar, lamellar, semicircular, 8–17 apart.

Female (based on 21 mature specimens): Body 25–69 mm long by 0.5–1.7

mm wide; ratio of greatest width to length 1:28–61. Lips 110–214 long by 132–222 wide. Nerve ring 414–646 from anterior extremity, 26–48 in breadth. Esophagus clavate, 2.6–7.2 mm long by 100–278 wide. Ventriculus 173–362 by 210–551; ventricular appendage 0.6–4.0 mm long by 0.2–1.1 mm wide; ratio for lengths of ventricular appendage to esophagus 1:1.5–4.5. Intestinal cecum 1.5–5.1 mm long by 80–488 wide; ratio of lengths of cecum to ventricular appendage 1:0.3–18.0; ratio of cecal to esophageal lengths 1:1.0–2.0. Vulva opening 7.3–35.1 mm or 25–40% of body length from anterior extremity, not protruding. Ovaries rarely extending anteriad beyond level of vulva. Eggs 18–63 in diameter. Tail 677–945 long, with tip usually without spines but single spine on one worm.

*Hosts*.—*Xiphias gladius* (Linnaeus), swordfish (Xiphiidae) type-host; *Tetrapturus albidus* (Poey), white marlin; *T. brevirostris* (Playfair), striped marlin (from Tanzania) (Istiophoridae).

*Site of infection*.—Stomach.

*Localities*.—Offshore from Destin (*T. albidus*) and Miami (*X. gladius*), Florida; Baltic Sea; off India; near Zanzibar, Tanzania.

*Specimens deposited*.—From *T. albidus* (2 pairs) USNM Helm. Coll. No. 75843; (pair) BMNH Reg. No. 1980.363–364; (pair) ZM No. 7053.

*Remarks*.—We examined six male and six female syntypes of *H. incurvum* (ZM No. 468) deposited by Rudolphi in October 1818, and, even though their condition was poor, we determined the presence of diagnostic deep interlabial grooves and modified ventral annules on the males. They lacked prominent cervical alae. Because of their condition and because we did not see all the syntypes, we refrain from establishing a lectotype, but nevertheless consider the specimens conspecific with our material, some of which came from the type-host. With the permission of G. Hartwich, who counted the same number and kind of postanal papillae on two syntypes that we did (personal communication), we deposited a female and the tail and two anterior fragments of male syntypes in the U.S. National Museum (USNM Helm. Coll. No. 75151).

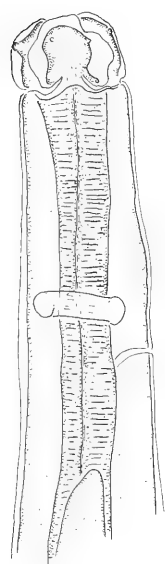
In our material the vulva did not protrude as reported by Berland (1961), suggesting that such a feature results from a shrinkage or fixation artifact as Berland proposed.

We also examined a male specimen (BMNH No. 1923.1.22.3) from a swordfish caught off India and identified by Baylis and Daubney (1922) as *Contracaecum incurvum* and 21 females and 5 males (BMNH No. 1962.40–47) from *Tetrapturus brevirostris* (as *Makaira audax*) caught near Zanzibar.

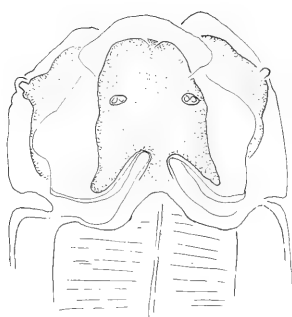
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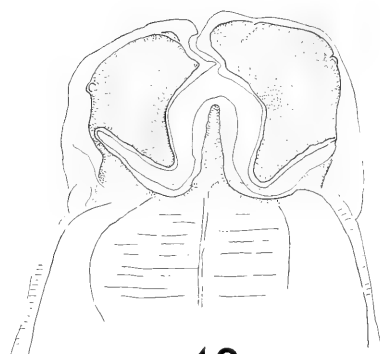
Figs. 46–52. *Hysterothylacium incurvum*: 46, Anterior end showing spacial relationship between excretory pore and nerve ring, lateral view; 47, Dorsal view of lips; 48, Ventral view of lips showing interlabium; 49, *En face*; 50, Posterior end of male showing both caudal papillae and annules on ventral surface, lateral view; 51, Posterior end of male showing postanal papillae, lateral view; 52, Posterior end of male showing postanal papillae, ventral view.



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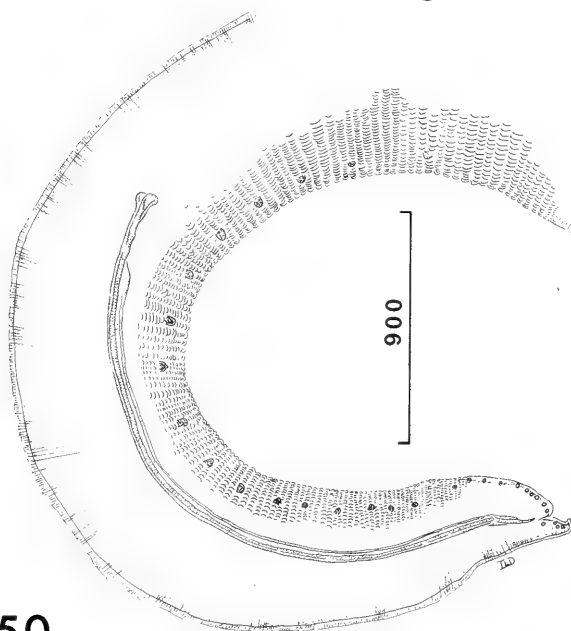
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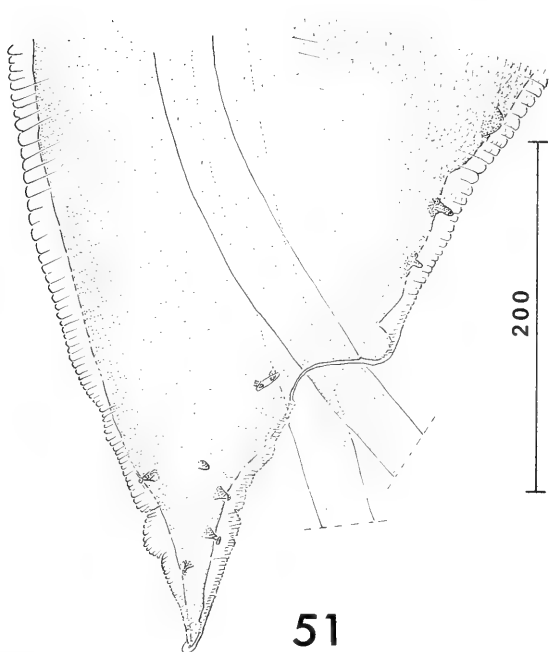
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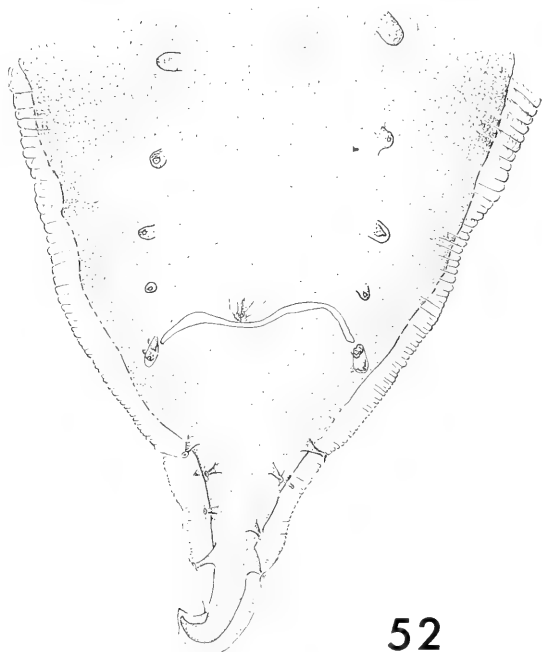
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All appeared to be *H. incurvum*. In fact, the species probably occurs throughout the range of swordfishes. Unconfirmed reports of *C. incurvum* indicate the worm's abundance in white marlin off Ocean City, Maryland (Wallace and Wallace, 1942) and the southern Gulf of Mexico (Nikolaeva and Parukhin, 1968) and in *T. audax* (as *Makaira mitsukurii* Jordan and Snyder) from Brett Cape to the Cavalli Islands, New Zealand (Morrow, 1952). Hosts other than swordfish such as the sailfish (as *Histiophorus gladius*), the Spanish mackerel, and the sand-bar shark, *Carcharhinus plumbeus* (Nardo) (as *Carcharias cerulcus*) have been reported as hosts of mature specimens (e.g., Linton, 1901; Walton, 1927; Nikolaeva and Parukhin, 1968), but such identifications also require confirmation.

Nikolaeva and Parukhin (1968) reported a maximum of 1,787 specimens from a single white marlin. We never encountered such heavy infections, but numerous individuals often exited from the mouth and opercula of dead fish to the disgust of fishermen.

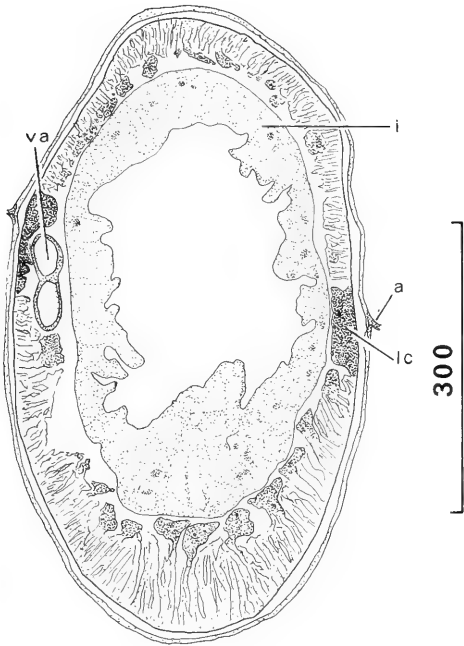
Only two species of *Hysterothylacium* have been reported from swordfishes and billfishes: *H. incurvum* and *H. histiophori*. Rudolphi (1819) originally described *Ascaris incurva* from the swordfish, *Xiphias gladius* Linnaeus, in the Baltic Sea, a rather rare locality for the host (A. Wheeler, personal communication). Yamaguti (1935) described *C. histiophori* from the sailfish *Istiophorus platypterus* (Shaw and Nodder) (as *Histiophorus orientalis*) in Toyama Bay, Japan. Neither Rudolphi nor Yamaguti provided many diagnostic features in their descriptions.

The status of *H. histiophori* has not been adequately ascertained. Yamaguti (1935), who based the description on one mature female and an immature pair, differentiated it from *H. incurvum*, which he reported from *Xiphias gladius* in the same paper, on the basis of body length and positions of both the nerve ring and vulva. We have been unable to locate type specimens of *H. histiophori* or any other specimens from the same host from the Meguro Parasitological Museum (Atsuo Ichihara, personal communication) or elsewhere. Olsen (1952) reported *C. histiophori* from the sailfish *I. platypterus* (as *I. americanus*) caught off the "Florida coast." We do not know whether these specimens (6 mature and 3 immature males, plus 3 mature and 14 immature females), not deposited in the U.S. National Museum, represent *H. histiophori* or a new species. In any event, even though it has deep interlabial grooves and modified ventral annules in the male, we consider its prominent cervical alae sufficient to differentiate the species from *H. incurvum*.

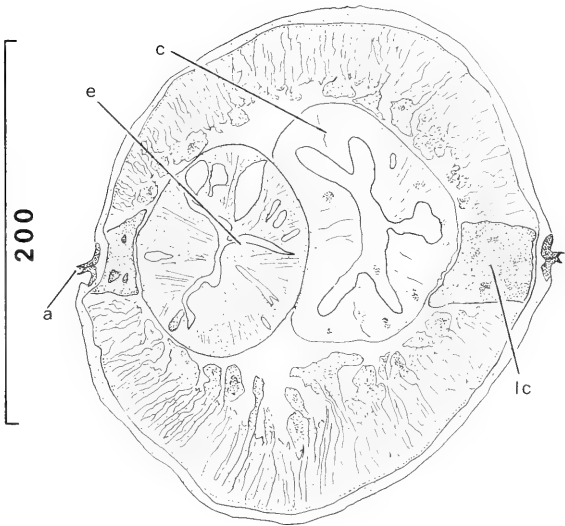
*Hysterothylacium corrugatum*, new species

Figs. 57-63

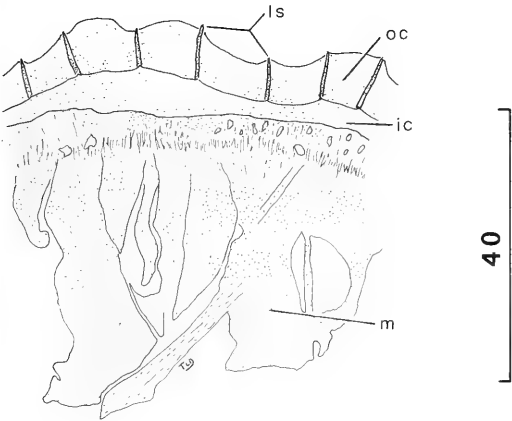
*Diagnosis.*—Cuticle with enlarged and modified annules on ventral surface of male near cloaca; lips with ratio of length to width 1:1.0-1.3, with



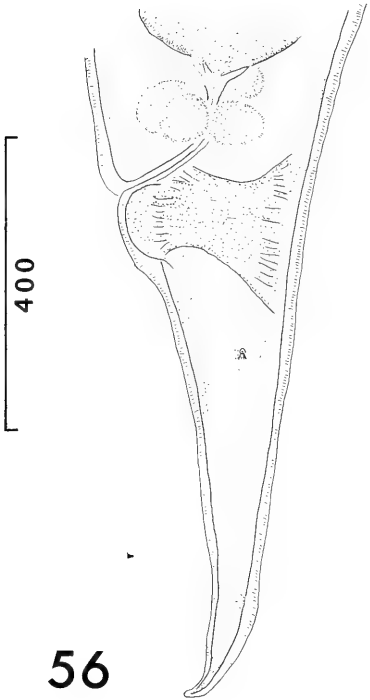
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Figs. 53–56. *Hysterothylacium incurvum*: 53, Cross-section of worm through level of ventricular appendage; 54, Cross-section of worm showing intestinal cecum; 55, Cross-section through modified annules on ventral surface of males; 56, Posterior end of female tail, lateral view. Abbreviations: a = lateral alae, c = intestinal cecum, e = esophagus, i = intestine, ic = inner cuticular layer, lc = lateral cord, ls = longitudinal supports, m = muscle, oc = outer cuticular layer, and va = ventricular appendage.

interlabial grooves lacking; caudal papillar pairs: preanal 24–26, postanal 4, para-anal 1, doubled; spicules 4–7% of body length; spicule-ratio 1:1.0; tail gradually tapering, terminating without ornamentation.

*General (based on specimens from Florida).*—Body reaching greatest width near midbody. Cuticle with inconspicuous annulations except ventrally on male's posterior. Cervical alae not flaring. Lips approximately equal in size, occasionally broader than long; flanges widest near base, indented at anterior  $\frac{2}{5}$ . Pulp for each lip not narrowed at base, each with 2–4 lobular projections often a few times longer than wide. Interlabia with height equal to or slightly less than width at base, with rounded tips; interlabial grooves lacking. Esophagus clavate, 5–13% of body length. Ventriculus narrower than widest level of esophagus, generally longer than broad; ventricular appendage descending without angulation from posterior portion of ventriculus. Nerve ring located between anterior 6–12% of esophagus. Excretory pore immediately posterior to level of nerve ring. Tail gradually tapering, terminating without ornamentation.

Male (based on 5 mature specimens): Body 26–50 mm long by 0.4–1.0 mm at greatest width; ratio of greatest width to length 1:49–69. Lips 96–145 long by 89–168 wide. Nerve ring 284–593 from anterior extremity, 30–48 in breadth. Esophagus 3.0–5.6 mm long by 60–191 wide. Ventriculus 36–154 long by 57–185 wide; ventricular appendage 2.4–3.8 mm long by 43–60 wide; ratio for lengths of ventricular appendage to esophagus 1:1.0–2.3. Intestinal cecum 2.3–4.6 mm long by 48–204 wide; ratio of cecal to ventricular appendage lengths 1:0.6–0.9; ratio of cecal to esophageal lengths 1:1.0–1.3. Spicules 4–7% of body length, similar; left spicule 1.2–2.5 mm long by 12–18 wide; right spicule 1.2–2.6 mm long by 12–18 wide; spicule-ratio 1:1.0. Caudal papillae 29–31 pairs, becoming closer together and more medial as approaching anus; preanal pairs 24–26; postanal pairs 4; para-anal pair 1, doubled. Medioventral preanal organ distinct, papillated. Tail flexed ventrad, 191–245 long. Modified annules on ventral surface, beginning near anus, extending anteriorly 1.0–4.1 mm or 3–15% of body length.

Female (based on 6 mature specimens): Body 100–142 mm long by 1.7–2.6 mm wide; ratio of greatest width to length 1:40–75. Lips 203–259 long by 210–247 wide. Nerve ring 709–756 from anterior extremity, 43–61 in breadth. Esophagus clavate, 5.5–8.5 mm long by 283–315 wide. Ventriculus 154–472 by 220–283; ventricular appendage 3.5–4.3 mm long by 80–98 wide; ratio of ventricular appendage to esophagus lengths 1:1.5–2.0. Intestinal cecum 5.3–7.2 mm long by 346–583 wide; ratio of lengths of cecum to ventricular appendage 1:0.6–0.7; ratio of cecal to esophagus lengths 1:1.0–1.2. Vulva opening 35–40 mm or 33–39% of body length from anterior extremity. Ovaries rarely extending antieriad beyond level of vulva. Eggs 40–80 in diameter. Tail 0.8–1.1 long.

*Host.*—*Xiphias gladius* (Linnaeus), swordfish (Xiphiidae).



*Site of infection*.—Stomach.

*Localities*.—Offshore from Miami (type-locality); Panama City, Florida; and Manta, Ecuador.

*Specimens deposited*.—Holotype, male, USNM Helm. Coll. No. 75844; Allotype, female, No. 75845; Paratypes, No. 75846 (pair), British Museum (Natural History) Reg. No. 1980.365–366 (pair); Additional specimens, ZM No. 7054 (female and anterior of male).

*Etymology*.—The Latin *corrugatum* means “ridged,” referring to the modified annules on the ventral surface of the males.

*Remarks*.—We examined three mature specimens, a male and two females (USNM Helm. Coll. No. 60051), from the swordfish caught at Manta, Ecuador, which were identified by M. Chitwood as *Contracaecum incurvum*. They lacked interlabial grooves, the male had 30 preanal papillae, and we consider them *H. corrugatum*.

Of the more than 300 nematodes from 22 specimens of white marlin caught offshore from Destin, Florida, to Orange Beach, Alabama, and the 85 from 4 specimens of the swordfish caught offshore from Miami and Panama City, Florida, only *H. incurvum* infected the white marlin, but both *H. incurvum* and *H. corrugatum* occurred in the swordfish.

By possessing modified annules on the ventral surface of the male, *H. corrugatum* most closely resembles *H. incurvum* and *H. histiophori* of Olsen (1952), but differs conspicuously by lacking deep interlabial grooves.

### *Hysterothylacium habena* (Linton), new combination

Figs. 64–67

*Ascaris habena* Linton, 1900:302–303, figs. 109–115 (original description; type-host *Opsanus tau*; type-locality Woods Hole, Massachusetts).

*Contracaecum habena*.—Linton, 1934:125 (distribution and prevalence records; new combination).

*Thynnascaris habena*.—Hartwich, 1957 (new combination).-

*Diagnosis*.—Cuticle with inconspicuous annulations; lips approximately as wide as long, narrowest at base, with ratio of greatest length to width 1:0.9–1.1, with labial flanges appearing as broad triangular projections slightly indented at anterior  $\frac{1}{4}$  of lip; pulp pedunculate; caudal papillar pairs: preanal 21–31; postanal 3–4, with 3rd pair from posterior extremity doubled; process on posterior extremity conical, multispinous.

*Remarks*.—Since Linton's (1900) original description of *H. habena* from the oyster toadfish, *Opsanus tau* (Linnaeus), from Massachusetts, it has been redescribed by Chandler (1943) and by Norris and Overstreet (1975). We reexamined 2 males and 1 female from *O. tau* collected at Gloucester Point, Virginia, reported by Norris and Overstreet and supplement that description below. A pair of prominent phasmids occurred laterally on the



spined distal process and three pairs of postanal papillae occurred on one specimen and four on the other. In both cases, the third pair from the posterior extremity was doubled. Designating papillae as para-anal is subjective for many species, including *H. habena*. Even though two pairs of papillae occur lateral to the lip anterior to the anus of *H. habena*, these appear as a continuum of preanal papillae as evident in ventral view (Fig. 64) rather than being clearly set-off and could therefore be considered pre-anal papillae. Ventral tail mounts are especially helpful in determining papillar patterns.

*Hysterothylacium habena* probably does not occur in the northern Gulf of Mexico as assumed by Hutton *et al.* (1962) and others. Their assumption was based on the presence of a larval species of *Hysterothylacium* (= *Contracaecum*) in penaeid shrimps from North Carolina to Central America and the Caribbean (actually at least three species infect these shrimps, Norris and Overstreet, 1976, personal observations) which have a ratio for the lengths of intestinal cecum to ventricular appendage similar to that for *H. habena*. *Hysterothylacium habena* extends from at least Massachusetts to Georgia in a batrachoidid from high-salinity habitats. We have not seen it among abundant ascaridoid material from batrachoidids collected in Florida, the northern Gulf of Mexico, and Central and South America.

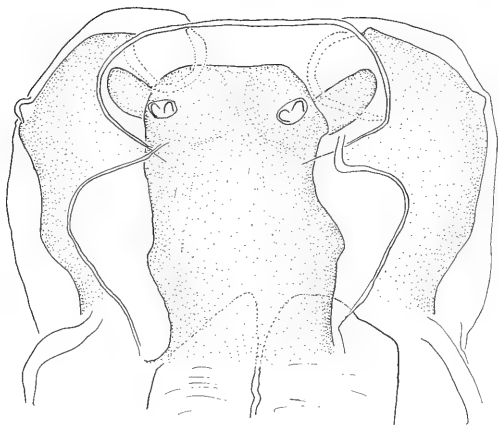
### *Iheringascaris* Pereira

*Iheringascaris* Pereira, 1935 (type-species *I. iheringascaris* Pereira, 1935, junior synonym of *I. inquires*).

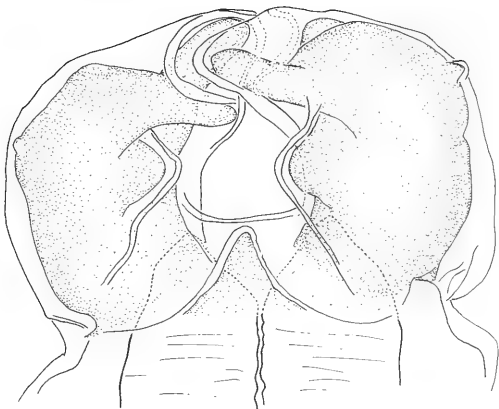
*Diagnosis*.—Body relatively narrow. Cuticle with distinctly plicated annulations lacking spines. Cuticular alae present. Lips approximately equal in size, bearing transparent cuticular flanges on lateral margins; dorsal lip with two lateral doubled papillae; subventral lips with amphid, adjacent mediolateral doubled papilla, and single lateral papilla. Dentigerous ridges absent. Interlabia present, without deep interlabial grooves. Ventriculus nearly spherical; ventricular appendage cylindrical with septum dividing structure into 2 equal longitudinal pouches; intestinal cecum shorter than ventricular appendage. Excretory system with duct off central commissure opening as pore near level of nerve ring, with excretory canals extending

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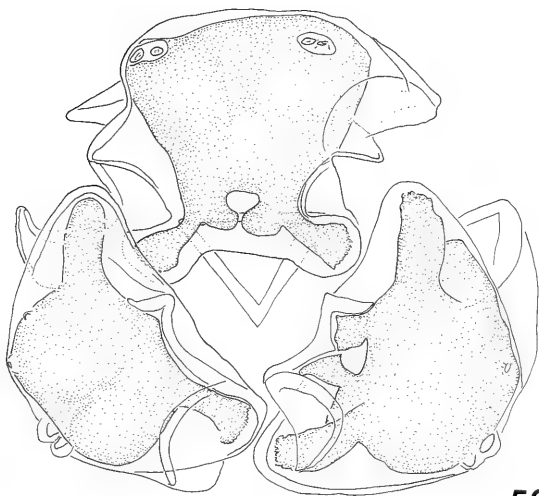
Figs. 57–63. *Hysterothylacium corrugatum*: 57, Dorsal view of lips; 58, Ventral view of lips showing interlabium; 59, *En face*; 60, Posterior end of male showing modified annules and postanal and para-anal papillae, ventral view; 61, Posterior end of male showing postanal and para-anal papillae, lateral view; 62, Posterior end of female tail, lateral view; 63, Posterior end of male showing entire view of spicules, lateral view.



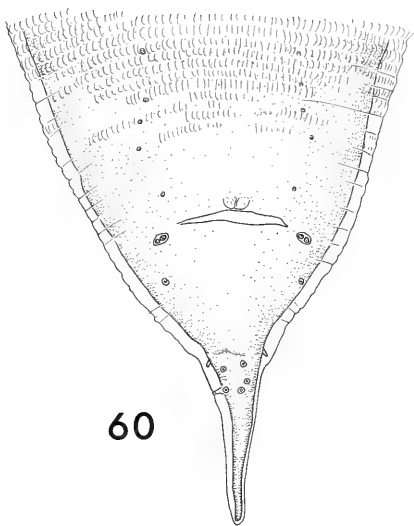
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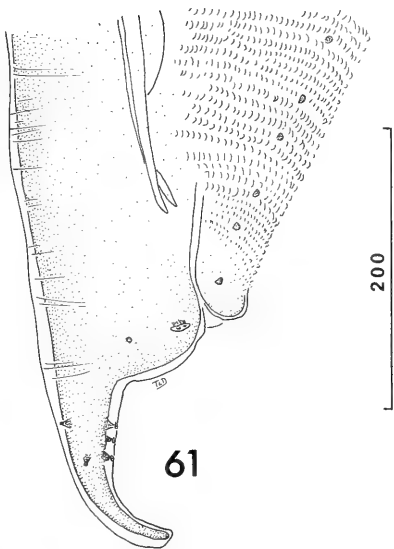
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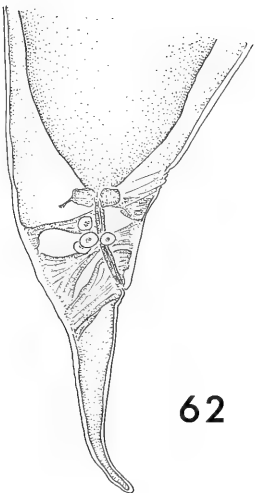
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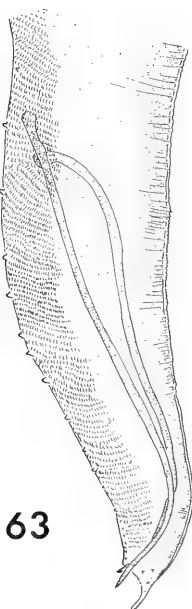
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62



63

posteriorly in both lateral cords. Spicules similar and approximately equal. Gubernaculum absent. Lateral row of caudal papillae in addition to regular pre- and postanal papillae. Medioventral preanal organ present. Vulva anterior to midbody. Uterus didelphic, opisthodelphic. Tail conical. Phasmids present. Parasites of marine fish. Type-species: *Iheringascaris iheringascaris* Pereira, 1935 (junior synonym of *I. inquires*, see below).

*Comparisons:* *Iheringascaris* has long been considered a junior synonym of *Thynnascaris* or its synonym *Contracaecum* (Johnston and Mawson, 1945). Its only species can be easily differentiated from those of *Hysterothylacium* by possessing distinctly plicated cuticular annulations and an additional lateral pair of caudal papillar rows. However, *H. cornutum* does have irregular lateral papillae extending anteriorly and posteriorly from the anal level. Once all species of *Hysterothylacium* are more critically evaluated, they may additionally differ if none have a similar excretory system.

Biological differences may also occur between *I. inquires* and species of *Hysterothylacium*. Adult *I. inquires* live abundantly free in the lumen of the pyloric ceca. Those in the stomach occur free, entwined in digesting prey, and embedded in the host's mucosal tissue. Fourth stage larvae embed in nodules generally causing much less host response than do related species of *Goezia* (see Deardorff and Overstreet, 1980). Iversen and Kelley (1974) suggested gastric ulcers invaded by "*Contracaecum* sp.?" in marlin resulted from mechanical injury by sharply pointed food items, possibly aggravated by the nematodes. We observed no *H. incurvum* or any other species of *Hysterothylacium* to embed in the alimentary tract of their hosts. Kalyankar (1972) reported larval *I. inquires* from gills of sea-crabs in Ratnagira, India, but that identification requires confirmation. Adults of *Goezia* are much wider than *I. inquires*, have spines on the plicated annulations, and have angulated overhanging lips.

*Iheringascaris inquires* (Linton), new combination

Figs. 68–84

*Ascaris inquires* Linton, 1901:452, pl. 6, figs. 46–50 (original description; type-host *Rachycentron canadum*; type-locality Buzzard's Bay, Massachusetts).

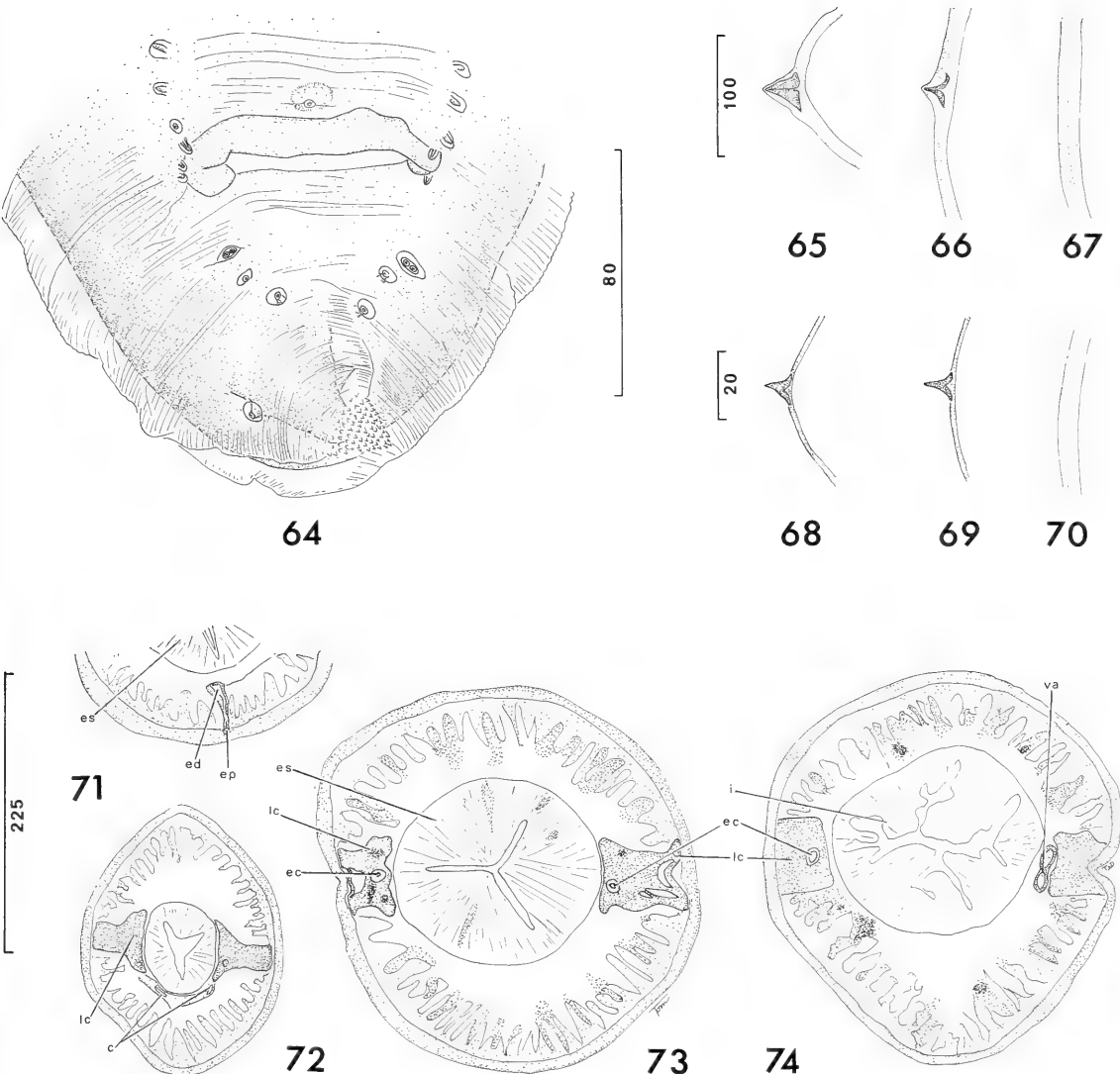
*Iheringascaris iheringascaris* Pereira, 1935:56–58, figs. 10–16 (original description; type-locality Natal, Estado do Rio Grande do Norte, Brazil).

*Contracaecum* (*Thynnascaris*) *inquires*.—Johnston and Mawson, 1945:132–133 (new combination).

*Thynnascaris iheringascaris*.—Hartwich, 1957:240–241 (new combination).

*Contracaecum iheringascaris*.—Yamaguti, 1961:28, pl. 5, fig. 36 (new combination).

*Thynnascaris inquires*.—Rasheed, 1965:323–329, figs. 18–28 (new combina-



Figs. 64–74. *Hysterothylacium habena* (64–67) and *Iheringascaris iniquies* (68–74): 64, Male tail of *H. habena*, ventral view; 65–67, Lateral ala at anterior (65), middle (66), and posterior (67) parts of female; 68–70, Lateral ala of *I. iniquies* at anterior (68) and midbody (69) of fourth stage larva and midbody (70) of mature male; 71–74, Cross-sections of excretory system showing excretory pore (71), excretory commissure (72), and excretory canals immediately anterior to intestinal cecum (73), and immediately posterior to esophageal-ventricular junction (74). Abbreviations: c = commissure, ec = excretory canal, ed = excretory duct, ep = excretory pore, es = esophagus, i = intestine, lc = lateral cord, va = ventricular appendage.

tion; redescription based on Linton’s specimens and others from Karachi, West Pakistan).

?*Neogoezia elacateiae* Khan and Begum, 1971:12–14, fig. 8 (original description; type-host *Rachycentron canadum* [as *Elacate nigra*]; type-locality Karachi Coast).

*Diagnosis.*—Cuticle with deep transverse annulations; lips with ratio of length to width 1:1.1–1.6; caudal papillar pairs: preanal 25–29, medial-postanal 6, lateral 6; spicules 23–25% of body length; spicule-ratio 1:0.8–1.2; digitiform process lacking ornamentation on posterior extremity.

*General (based on specimens from Mississippi and Alabama).*—Body reaching greatest width near midbody. Cuticle with deep transverse annulations along entire length. Lateral alae extremely reduced or absent in adults (relatively prominent in fourth stage larva). Lips approximately equal in size, wider than long; flanges widest near posterior, indented at anterior  $\frac{1}{3}$ ; pulp pedunculated. Interlabia with height equal to or slightly greater than width at base; interlabial grooves lacking. Cervical papillae small, near nerve ring. Esophagus 12–15% of body length. Ventriculus narrower than widest level of esophagus, usually longer than broad; ventricular appendage descending without angulation from posterior portion of ventriculus. Nerve ring at anterior 10–23% of esophagus. Excretory pore immediately posterior to level of nerve ring; excretory canal in right lateral cord terminating slightly anterior to level of tip of intestinal cecum; canal in left lateral cord extending considerably farther posteriorly. Tail conical.

Male (based on 20 mature specimens): Body 20–27 mm long by 216–709 at greatest width; ratio of greatest width to length 1:54–94. Lips 72–132 long by 96–144 at greatest width. Nerve ring 204–442 from anterior extremity, 31–55 in breadth. Esophagus 2.0–4.0 mm long by 116–144 wide. Ventriculus 74–166 long by 92–135 wide; ventricular appendage 1.3–1.7 mm long by 50–70 wide; ratio for lengths of ventricular appendage to esophagus 1:1.9–2.5. Intestinal cecum 330–649 long by 75–105 wide; ratio of cecal to ventricular appendage lengths 1:1.7–4.2; ratio of cecal to esophageal lengths 1:5–8. Spicules bifurcate at tip, covered by thin sheath, 23–25% of body length, unequal; left spicule 5.3–9.2 mm long by 12–15 wide; right spicule 5.8–10.7 mm long by 12–15 wide, usually longer than left spicule; spicule ratio 1:0.8–1.2. Caudal papillae 37–41 pairs, becoming closer together and more medial as approaching anus; preanal pairs 25–29; medial-postanal pairs 6 with 3rd from posterior end doubled; lateral pairs 6. Medioventral preanal organ simple, distinct, papillated. Tail flexed ventrad, 79–132 long.

Female (based on 20 mature specimens): Body 14–35 mm long by 253–709 wide; ratio of greatest width to length 1:54–70. Lips 86–127 long by 122–151 wide. Nerve ring 450–550 from anterior extremity, 16–34 in breadth. Esophagus 2.0–3.5 mm long by 80–140 wide. Ventriculus 110–170 long by 62–130 wide; ventricular appendage 1.2–2.0 mm long by 77–105 wide; ratio for lengths of ventricular appendage to esophagus 1:1.6–2.5. Intestinal cecum 260–505 long by 50–100; ratio of cecal to ventricular appendage lengths 1:1.7–4.3; ratio of cecal to esophageal lengths 1:6.0–7.1. Vulva without salient lips, opening 10.0–11.7 mm or 31–38% of body length from anterior extremity. Ovaries rarely extending anteriorly to level of vulva. Eggs 40–60

in diameter. Tail 250–611 long. Phasmids 1 pair, located laterally, equatorially between anus and posterior extremity of tail.

*Host*.—*Rachycentron canadum* (Linnaeus), cobia (Rachycentridae).

*Sites of infection*.—Stomach and pyloric ceca.

*Localities*.—Mississippi Sound, Mississippi; Alabama Point, Alabama; Buzzard's Bay, Massachusetts; Lower Chesapeake Bay, Virginia; Natal, Brazil; and Karachi, West Pakistan.

*Specimens deposited*.—(2 pairs) USNM Helm. Coll. No. 75847; (1 pair) OCI 31.605; (1 pair) BMNH Reg. No. 1980.367–368.

*Remarks*.—Linton (1901) originally described *Ascaris inquires* from material removed from the stomach of *Rachycentron canadum* near Woods Hole, Massachusetts. He reported 24 pairs of preanal papillae and 4 pairs of postanal ones. Because Linton's description and illustrations were inadequate, Rasheed (1965) redescribed it using one of Linton's deposited specimens and those removed from the same host species in West Pakistan. She transferred it to *Thynnascaris*, agreed with the presence of 24 pairs of preanal and 4 pairs of medial-postanal papillae, and noted an additional 4 lateral pairs of papillae which Linton had missed. Since the holotype was not available, we examined two male and five female specimens (USNM Helm. Coll. No. 6622) deposited by Linton in 1899 from the type-host and type-locality. On the best male specimen, we counted 6 lateral, 6 medial-postanal, and 24 pairs of preanal papillae. We also examined specimens (VIMS Host No. S-498) from a cobia caught in Lower Chesapeake Bay, off Seaford, Virginia, with similar papillar counts; the doubled papillae were obvious. Our specimens from the northern Gulf of Mexico showed no marked differences with those or with Rasheed's specimens (BMNH 1964.1523–1532) which we also examined and are consequently considered conspecific with them. With the permission of Rodney Bray, Parasitic Worm Section, British Museum (Natural History), we deposited one pair of Rasheed's specimens in the U.S. National Museum (USNM Helm. Coll. No. 75545).

We also examined four specimens, 3 males and 1 female, of *Iheringascaris iheringascaris* loaned to us by J. J. Vicente (OCI No. 17.157) from *R. canadum* in Brazil. Pereira (1935) listed the type-host as "bijupirá" which, according to Vicente, is a common name for *Rachycentron canadum*. The elongated specimens we examined were fragments or had stripped cuticles. Nevertheless, we counted at least 18 pairs of preanal, 6 pairs of medial-postanal, and 6 pairs of lateral papillae and confirmed the characteristic annulations. These features in addition to the measurements in the original description reported by Pereira (1935) prompt us to consider *Iheringascaris iheringascaris* a junior synonym of *I. inquires*.

Species of *Hysterothylacium* purported to possess conspicuous transverse annulations are *H. cornutum* from *Thunnus thynnus* (Linnaeus) (as

*T. vulgaris*) at Trieste, Italy, and *H. carangis* from the intestine of *Caranx malabaricus* Day at Panjim, India. *Hysterothylacium cornutum* was originally described by Stossich (1904), and Baylis (1923) later added to that description using Stossich's original material. Baylis noted that the cuticular striations had "rather prominent edges, like minute sawteeth." We examined these specimens of *H. cornutum*, 2 males and 2 females (BMNH No. 1931.10.20.80-89), but observed fine cuticular annules such as typically seen on adult specimens of some species of *Hysterothylacium*. Kalyankar (1971) stated that the striations of *H. carangis* were "not so distinct at the anterior and posterior extremities of the male, but very distinct in the middle of the body." In female specimens these striations were apparently very distinct with the exception of the "anterior-most region." Cuticular annulations of *I. inquires* are consistently conspicuous at all regions of both male and female worms. *Hysterothylacium carangis* is reported to have 28 caudal papillae in contrast to the 36-42 on *I. inquires*. Kalyankar purported two spicules of equal length; yet, his illustration showed the left spicule slightly longer than the right. In *I. inquires* the right is usually slightly longer than the left. Kalyankar stated that *H. carangis* differed from *I. inquires* by possessing a straight blunt tail and a postequatorial vulva. *Hysterothylacium carangis* needs critical re-examination. In any event, *I. inquires* differs from *H. cornutum* and apparently from *H. carangis*.

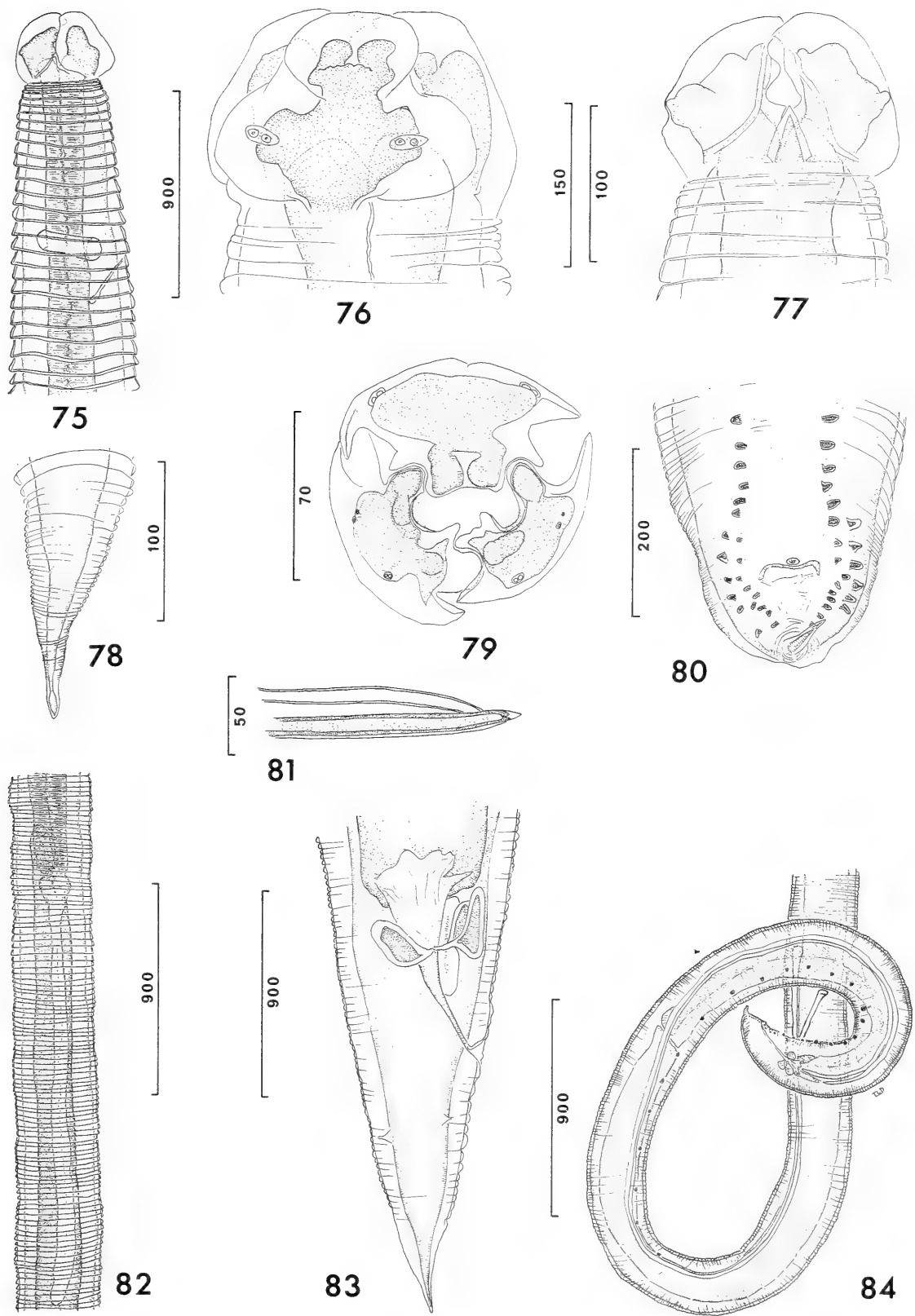
Khan and Begum (1971) described *Neogoezia elacateiae* from *Elacate nigra* (Day) (= *Rachycentron canadum*) off the coast of Karachi, West Pakistan. That host and locality are the same as Rasheed reported for *H. inquires*. Also, those authors' description and illustrations show the conspicuous transverse cuticular annulations and other diagnostic features of *I. inquires*. They, however, did not observe interlabia or a ventricular appendage, and they reported 11 preanal papillae without mentioning lateral, para- or postanal papillae. To date we have been unsuccessful in corresponding with Khan. Consequently, until Khan and Begum's specimens can be reexamined, we suggest that *Neogoezia elacateiae* may be a junior synonym of *I. inquires*.

In addition to the previous diagnoses, the following key should permit

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Figs. 75-84. *Itheringascaris inquires*: 75, Anterior end showing conspicuous annulations and spacial relationship between excretory pore and nerve ring, lateral view; 76, Dorsal view of lips; 77, Ventral view of lips showing interlabium; 78, Posterior extremity of female tail, lateral view; 79, *En face*; 80, Male tail showing lateral and medial postcloacal papillae, ventral view; 81, Tip of spicule, lateral view; 82, Body at level of intestinal-ventricular junction, lateral view; 83, Female tail, lateral view; 84, Posterior end of male showing caudal papillae, lateral view. (Portions of the annulations in Figs. 80, 83, and 84 were omitted for clarity of other structures.)







rapid identification of adults of species of *Hysterothylacium* reported in this paper.

Key to the Species of *Iheringascaris* and *Hysterothylacium*  
Parasitizing Fishes in the Northern Gulf of Mexico

1. Cuticle with deep transverse annulations (Fig. 75); 25–29 pairs of preanal, 6 pairs of medial-postanal, and 6 pairs of lateral-postanal papillae. Host: *Rachycentron canadum*. Western North Atlantic and Gulf of Mexico (also Brazil and Pakistan) ..... *I. inquires* (Linton, 1901)
  - Cuticle lacking deep transverse annulations ..... 2
2. Cervical alae prominent (Figs. 1, 4); 16–25 pairs of preanal, 8 pairs of postanal, and no para-anal papillae; tuft of spinous-like projections at posterior extremity. Hosts: *Scomberomorus brasiliensis*, *S. maculatus*, *S. cavalla*, and *Oligoplites saurus*. Gulf of Mexico (also Atlantic coasts of Florida and Brazil) .... *H. fortalezae* (Klein, 1973)
  - Cervical alae not prominent ..... 3
3. Cuticle with ventral crests (enlarged, modified annules [Figs. 50–52]) anterior to anus on male ..... 4
  - Cuticle lacking ventral crests on males ..... 5
4. Interlabial grooves deep (Figs. 47, 48); spicules 12–25% of body length. Hosts: *Xiphias gladius* and *Tetrapturus albidus* plus other marlin. Gulf of Mexico (also in Baltic Sea and off Floridian Atlantic coast, India, Tanzania, and probably Japan, New Zealand, and elsewhere) ..... *H. incurvum* (Rudolphi, 1819)
  - Interlabial grooves lacking; spicules 4–7% of body length. Host: *Xiphias gladius*. Gulf of Mexico (also off Floridian Atlantic coast and Ecuador) ..... *H. corrugatum*, sp. n.
5. Tail tip with relatively large projections on tuft (Figs. 42, 45); 23 pairs of preanal and 7 pairs of postanal papillae; pulp of lips not pedunculate. Host: *Chaunax pictus*. Gulf of Mexico ..... *H. chaunaxi* (Olsen, 1952)
  - Tail tip with dense covering of minute spinous structures or lacking ornamentation ..... 6
6. Lateral flanges of lips indented equatorially (Figs. 22–24); spicules 3–8% of body length; multispinous conical process at posterior extremity. Hosts: numerous fishes (see text). Gulf of Mexico (also Pacific and Caribbean coasts of Central America and Atlantic coast of South America to Brazil) . . *H. reliquens* (Norris and Overstreet, 1975)
  - Lateral flanges of lips indented at anterior  $\frac{1}{3}$  of lip (Figs. 14, 15); length of spicules 1–2% that of body; digitiform process on posterior extremity of tail lacking ornamentation. Hosts: *Ogcocephalus ra-*

*diatus* and *O. cubifrons*. Gulf of Mexico (and Floridian Atlantic coast)  
..... *H. ogcocephali* (Olsen, 1952)

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## SYLLIDAE (POLYCHAETA), PRINCIPALLY FROM FLORIDA, WITH DESCRIPTIONS OF A NEW GENUS AND TWENTY-ONE NEW SPECIES

Thomas H. Perkins

*Abstract.*—The following new species are described: *Brania gallagheri*, *Dioplosyllis octodentata*, *Exogone arenosa*, *E. atlantica*, *Odontosyllis longigulata*, *Pionosyllis gesae*, *Plakosyllis quadrioculata*, *Sphaerosyllis aciculata*, *S. bilobata*, *S. brevidentata*, *S. glandulata*, *S. magnidentata*, *S. piriferopsis*, *S. riseri*, *S. taylori*, *Streptosyllis pettiboneae*, *Syllides bansei*, *S. floridanus*, *Trypanosyllis inglei*, *T. parvidentata*, and *T. savagei*. *Dentatisyllis*, n. gen., is proposed for *Syllis carolinae* Day. *Brania swedmarki* Gidholm is newly reported for the western Atlantic. *Brania wellfleetensis* Pettibone is newly reported from Tampa Bay, Florida. *Exogone longicirris* (Webster and Benedict) is removed from synonymy with *E. dispar* (Webster), and both and *E. lourei* Berkeley and Berkeley are additionally described. *Parapionosyllis longicirrata* (Webster and Benedict) is newly reported from both coasts of Florida, and *Pionosyllis manca* Treadwell from Virginia is reported as a synonym. Presence of *Pionosyllis uraga* Imajima, originally described from Japan, is confirmed for North Carolina and newly reported from Florida. Florida specimens of *Trypanosyllis coeliaca* Claparède are described. *Sphaerosyllis longicauda* Webster and Benedict is removed from synonymy with *S. erinaceus* Claparède and redescribed. North American specimens previously referred to *S. hystrix* Claparède are referred to *S. taylori*, n. sp. Specimens from North Carolina previously referred to *S. pirifera* are referred to *S. glandulata*, n. sp. Characters of systematic importance to *Sphaerosyllis* Claparède are discussed, and a key is given for 13 species of the genus from the northwestern Atlantic Ocean.

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This report is one of several (Perkins, 1979) based primarily on specimens collected between September 1971 and July 1973 in an environmental baseline study of marine biota near the Florida Power and Light Company nuclear power plant at Hutchinson Island, St. Lucie County, Florida. Specimens representing significant range extensions and numerous new species from these collections are reported herein. Some Syllidae collected at Hutchinson Island are not included in this report, but will be included in a complete report on the Polychaeta which is in preparation. Additional specimens collected later at Hutchinson Island and other specimens from Maine to the Florida Keys, Bimini, Bahamas, the eastern Gulf of Mexico and the Northeast Pacific are included.

The study area was characterized and methods of collection were described by Gallagher and Hollinger (1977). Sediments were described by Gallagher (1977); other aspects of the physical and chemical environment were reported by Worth and Hollinger (1977). Brief descriptions of sampling stations and methods were also given by Perkins (1979).

Types and other specimens available for study are deposited in the Allan Hancock Foundation, University of Southern California (AHF), the Invertebrate Reference Collection of the Florida Department of Natural Resources Marine Research Laboratory (FSBC I), the U.S. National Museum of Natural History, Smithsonian Institution (USNM), the Virginia Institute of Marine Science Invertebrate Collection (VIMS), and the Zoologisches Museum, Hamburg (ZMH).

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*Brania* Quatrefages, 1865

*Brania swedmarki* Gidholm, 1962

*Brania swedmarki* Gidholm, 1962:256–258; fig. 3.—Hartmann-Schröder, 1974a:195, 196.

*Material examined*.—FLORIDA: Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 11 specimens (USNM 60475; FSBC I 20576). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 2 specimens (FSBC I 20577, 20578). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 3 specimens (FSBC I 20579–20581).

*Remarks*.—*Brania swedmarki* was described from Roscoff, France, and has since been reported from the northwestern North Sea (Hartmann-Schröder, 1974a). Hutchinson Island specimens are in excellent agreement with Gidholm's (1962) description except for variations attributable to differences in preservation or state of contraction.



Specimens from the Florida east coast represent the first Western Atlantic records for the species.

*Brania wellfleetensis* Pettibone, 1956

Fig. 1

*Brania wellfleetensis* Pettibone, 1956:282, fig. 2a-c; 1963:134, 135, fig. 35h. *Brania* sp. Taylor, 1971:223-225, fig. 5a, b.—Hall and Saloman, 1975:12 [list].

*Material examined*.—MASSACHUSETTS: Wellfleet Harbor, Cape Cod Bay side, sandy bottom, among tubes of *Diopatra cuprea* (Bosc); 25 Aug. 1953; holotype (USNM 27783). Chappaquoit, Buzzards Bay, muddy sand; paratype (USNM 27784). FLORIDA, GULF OF MEXICO: Hillsborough Bay, Tampa Bay; S. Santos col. and det., 1975-1979; 32 specimens (USNM 60477; FSBC I 22498; AHF 367; J. L. Simon). Same, 27°49'03"N, 82°26'07"W, sand, 4 m; J. Taylor and C. Saloman cols., 4 Sep. 1963; 3 specimens (FSBC I 15458). Upper Tampa Bay, 27°49'29"N, 82°33'50"W, shelly sand, 1 m; J. Taylor and C. Saloman cols., 27 Aug. 1963; 24 specimens (FSBC I 15456). Same, 27°49'28"N, 82°33'24"W, sand, 5 m; J. Taylor and C. Saloman cols., 27 Aug. 1963; 2 specimens (FSBC I 15457). Lower Tampa Bay, 27°36'56"N, 82°41'05"W, sand, 9 m; J. Taylor and C. Saloman cols., 25 Oct. 1963; 2 specimens (FSBC I 17924). Same, 27°34'54"N, 82°43'01"W, sand, 7 m; J. Taylor and C. Saloman cols., 30 Oct. 1963; 1 specimen (FSBC I 15459). Same, 27°34'24"N, 82°42'53"W, sand with algae cover, 6 m; J. Taylor and C. Saloman cols., 4 Nov. 1963; 1 specimen (FSBC I 15460). Same, 27°35'26"N, 82°45'27"W, sand with algae and *Thalassia* cover, 3 m; J. Taylor and C. Saloman cols., 9 Oct. 1963; 2 specimens (FSBC I 13187).

*Additional description*.—Holotype: mature male with sperm in setigers 12-34 of 41 setigers, without natatory setae, with notoacacula between dorsal cirri and parapodial lobes first visible at about setiger 20 and continuing to setiger 33. Prostomium with anteromedian part forming rounded, obtuse angle. Antennae, tentacular cirri and dorsal cirri slightly pseudoarticulated [preserved]. Parapodia mostly with 4 compound setae but 1-2 additional setae on anterior parapodia (Fig. 1c); upper one with blade edge oriented ventrally; lower 3 with blade edges oriented dorsally; blades with about 5 long, slender serrations; shafts with few indistinct serrations below tip. Superior simple setae beginning on setiger 34 (Fig. 1a, b), with pointed, slightly hooked tips, mostly with 2 large serrations below tip and indistinct serrations below. Inferior simple setae on last 3 or 4 setigers (Fig. 1d), slightly curved, with pointed tips, without serrations or hairs below tips. Acicula solitary, with slightly knobbed tips. Pygidium with 3 anal cirri (Pettibone, 1963). Pharynx coiled, with small, indistinct middorsal tooth slightly back

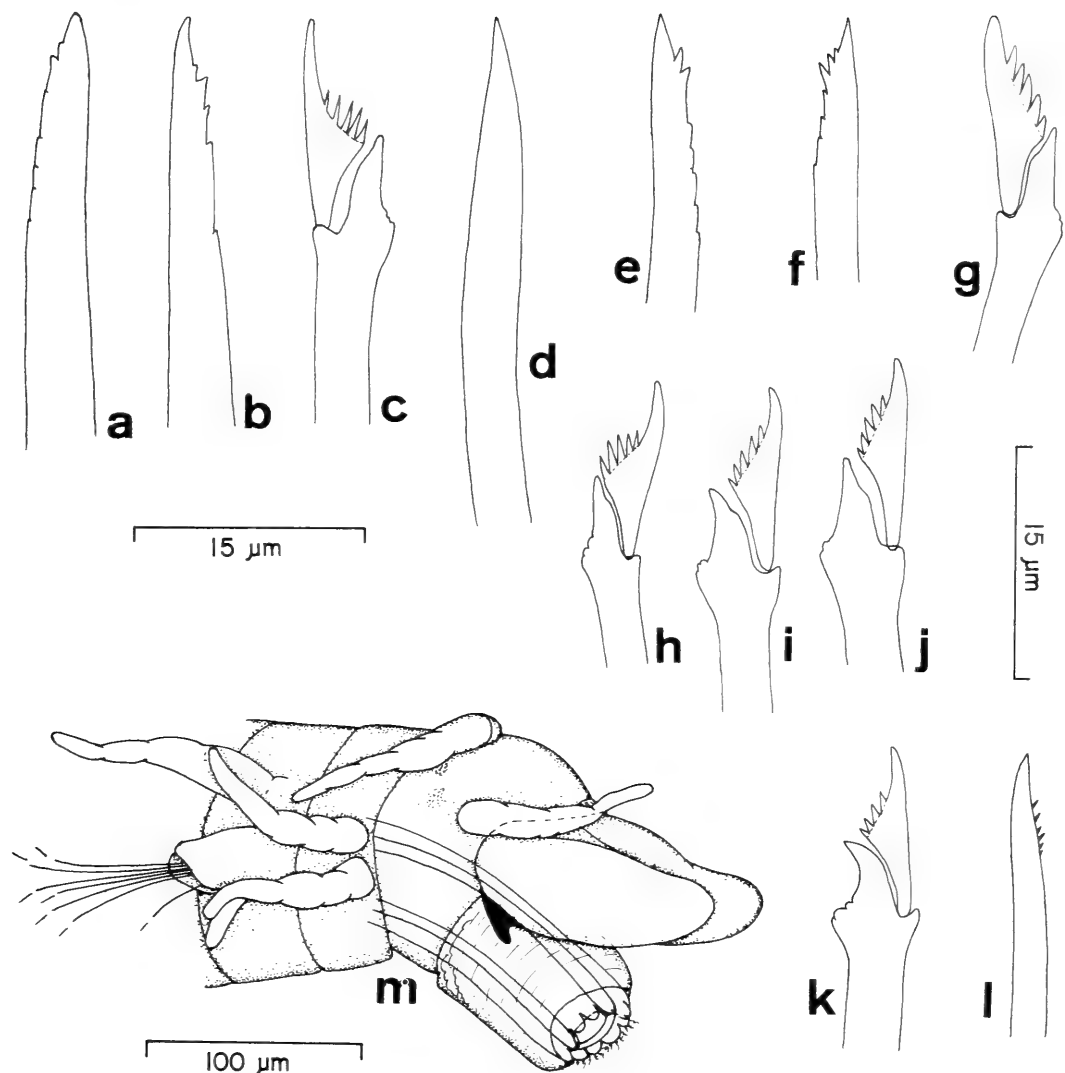


Fig. 1. *Brania wellfleetensis*: a, Superior simple seta, setiger 37; b, Same, setiger 38; c, Compound seta, setiger 37; d, Inferior simple seta, setiger 38; e, f, Superior simple setae, posterior setigers; g, Upper compound seta, middle setiger; h, Same, posterior setiger; i, Middle compound seta, posterior setiger; j, Lower compound seta, middle setiger; k, Same, posterior setiger; l, Inferior simple seta, posterior setiger; m, Anterior end with pharynx everted, lateral view, pharyngeal tooth darkened (a–d, holotype; e–m, Tampa Bay specimens, J. L. Simon).

from rim. Proventriculus cylindrical, 5 times longer than diameter, with 27 rows of muscle cells with anterior 6 rows small.

Tampa Bay, Florida, specimens: mature specimens larger than holotype, with up to about 55 (39–55) setigers. Pharynx brown on some specimens. Eyes of some mature specimens enlarged, with lenses; small, without lenses on others; easily damaged, often not visible (Fig. 1m). Superior simple setae of mature specimens similar to those of holotype (Fig. 1e, f), beginning on

more anterior setigers (13–30) on mature specimens. Compound setae (Fig. 1g–k) with blades slightly stouter than those of holotype, with similar number of stouter serrations; shafts similar, often stouter below. Inferior simple setae on several posterior segments (Fig. 1l) with tips pointed and few small serrations below tips. Pharynx longer than proventriculus, extending from posterior half of setiger 1 to posterior part of setiger 6 when inverted; anterior rim surrounded by 10, soft, ciliated papillae; middorsal tooth small; tip back from rim by about  $\frac{1}{6}$  of total length (Fig. 1m). Proventriculus long, cylindrical, about 3 segments long in setigers 6–9, with about 30 (28–32) rows of muscle cells in mature specimens.

Sexually mature specimens with sperm and eggs or ventrally attached embryos beginning on setigers 12–14 and extending to setigers 27–43. Notoacacula in sexual segments; one female with long natatory setae; males with natatory setae not seen. Six-setiger stage embryos without dorsal cirri on setiger 2 attached by pygidial end below ventral cirri of one female (USNM 60477).

*Remarks.*—Specimens from the Tampa Bay area differ from the holotype in having a larger number of segments on most mature specimens; however, some mature specimens are about the same size. They also differ from the holotype in having superior simple setae of most specimens beginning on more anterior segments and in always having inferior simple setae with a few small serrations below the tips.

*Brania wellfleetensis* has previously been reported only from Massachusetts. Gulf of Mexico specimens reported herein may constitute a disjunct population, with only slight differences from the more northern form.

*Brania gallagheri*, new species

Figs. 2, 3

*Material examined.*—FLORIDA: Hutchinson Island Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand, holotype (R. Gallagher col., Jan. 1972; USNM 60209), 13 paratypes (USNM 54503, 54504; AHF Poly 1305; ZMH P-16386–16388, FSBC I 20597, 20598, 20603–20605). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 3 paratypes (USNM 54502; AHF Poly 1306; FSBC I 20583). Sta. III, 27°22.0'N, 80°12.4'W, about 7 m, medium calcareous sand; 19 paratypes (AHF Poly 1307; FSBC I 20584–20593, 20595, 20596).

*Description.*—Well-preserved, sexually mature specimens of 50–60 setigers 5–7 mm long, 0.2–0.5 mm wide with parapodia. Body without color markings; eyes orange to dark red; pharynx often brown with ring of yellowish brown cells anterior to rim. Prostomium (Fig. 2a–c) about twice as wide as median length, anteromedian part forming rounded, obtuse angle; lateral margins rounded; posterior margin straight. Two pairs of eyes near

lateral margins of posterior half; outer, anterior pair more lateral; small, composed of aggregated pigment spots on most specimens; large, with lenses, with outer pair larger on some sexually mature males and females. Median antenna originating near posterior margin, extending about to tips of palps or beyond, similar to upper tentacular cirri. Lateral antennae originating on anterior margin anterior to eyes, extending about to tips of palps, similar to lower tentacular cirri. Posterior third of palps fused, each about as long as prostomial width on noncompressed specimen (Fig. 2a). Tentacular segment similar but slightly shorter than following segment, upper tentacular cirri subequal to median antenna, extending about to tips of palps. Lower tentacular cirri shorter, similar to lateral antennae. Dorsal cirri of setiger 1 slender, longer than median antenna and upper tentacular cirri. absent on setiger 2; slenderer than those on setiger 1, extending to or beyond tips of setae on other setigers; all originating on short cirrophores (Fig. 2a, d). Parapodial lobes distally truncate, bilabiate. Ventral cirri originating from lower margins of parapodial lobes, slightly slenderer than dorsal cirri, extending about to tips of parapodial lobes. Solitary, superior simple setae (Fig. 3a–c, i, j) above acicula beginning on setiger 14–21 of mature specimens, 8–20 on other specimens, with tips bluntly-pointed, 1–2 blunt to pointed teeth near tips above indistinct, irregular serrations on large specimens; tips pointed on juveniles. Usually 4 compound setae (Fig. 3d–f, k–m), 1–2 additional ones on anterior setigers; upper ones with blade edges oriented ventrally; lower 3 with blade edges oriented dorsally; blades short, falcigerous, unidentate, with up to 7 relatively stout serrations on larger specimens, fewer serrations on juveniles (Fig. 3k–m); shafts with few indistinct serrations on protuberance below tips; lower shafts greatly inflated on some middle and posterior parapodia of mature specimens (Fig. 3f), slender on juveniles (Fig. 3m). Solitary, bidentate inferior simple setae on few posterior segments (Fig. 3g, n). Acicula solitary, with knobbed tips (Fig. 3h). Pygidium with 3 anal cirri; long, subcylindrical lateral pair about as long as last 3 or 4 segments; shorter, slenderer median one originating ventrally (Fig. 2e). Males with sperm beginning in setiger 15–18, extending to setiger 49 in specimen of 59 setigers; with short, natatory setae and notoacacula (Fig. 2d) between bases of dorsal cirri and parapodial lobes, or with only notoacacula, beginning on setiger 20 or 21 and extending to about end of sexual region. Females with eggs beginning in setigers 16 or 17 and long, natatory setae and notoacacula, or with only notoacacula, beginning on setiger 18 and extending to about 10 segments from posterior end.

Pharynx relatively thick-walled, extending to about setiger 6, with long, broad, anterior middorsal tooth (Fig. 2b, c), anterior end surrounded by 10 soft, ciliated lobes. Proventriculus of adults cylindrical, slightly longer than pharynx, 5–6 times longer than diameter, in 7–9 segments, with about 45 rows of muscle cells, with anterior 6 rows small. Ventricle convoluted in

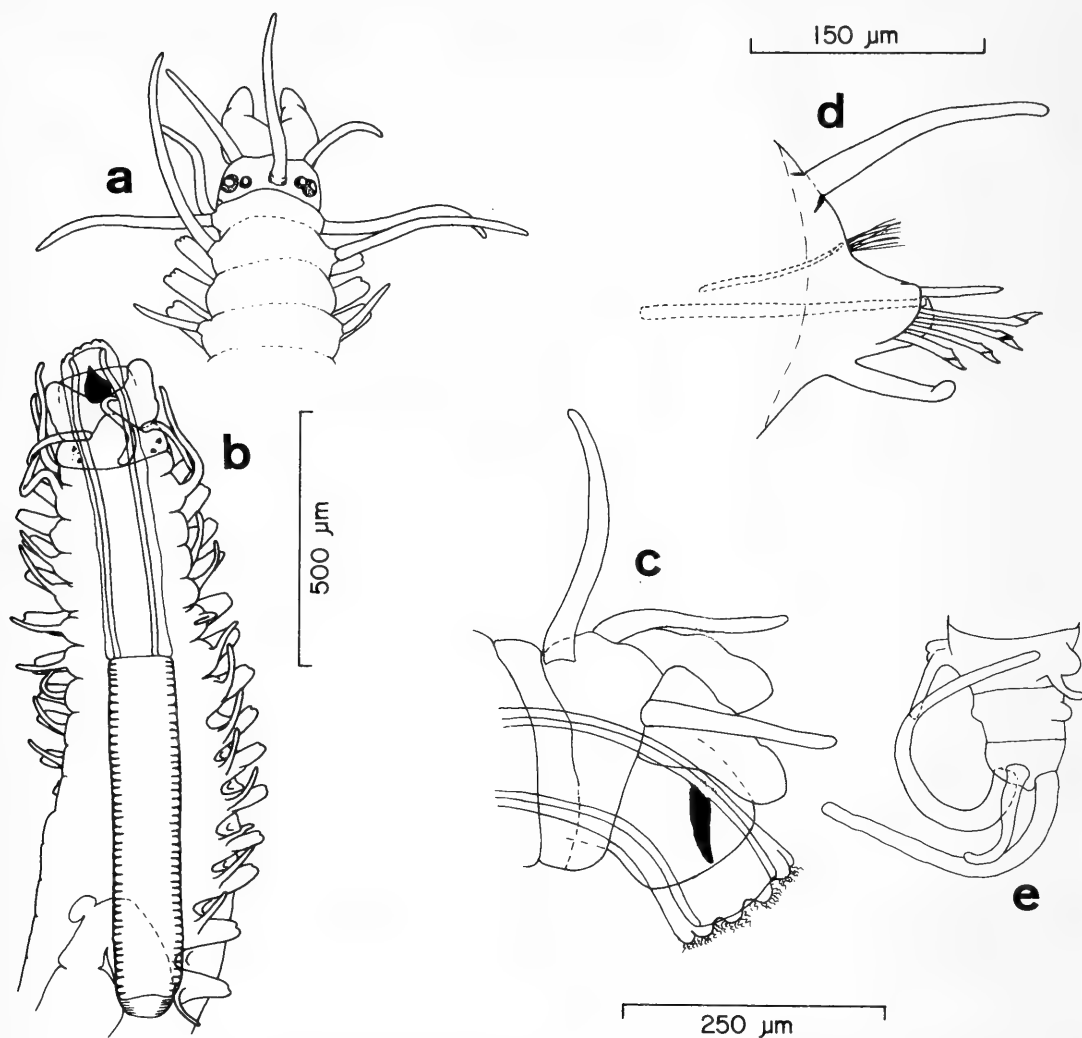


Fig. 2. *Brania gallagheri*: a, Anterior end, dorsal view; b, Same, slightly flattened showing internal structure, pharyngeal tooth darkened; c, Same, lateral view; d, Parapodium of setiger 37 of male, slightly turned anterior view; e, Pygidium, ventral view (a, d, USNM 54502; b, FSBC I 20601; c, e, USNM 54503).

figured specimen (Fig. 2b), 1–2 segments long depending on state of contraction.

**Remarks.**—*Brania gallagheri* is very similar to *B. wellfleetensis* Pettibone in general shape. However, *B. gallagheri* has longer and slenderer antennae and cirri and a larger, broader middorsal pharyngeal tooth. The proventriculus of *B. gallagheri* is about 6 segments long with about 45 rows of muscle cells, while that of *B. wellfleetensis* is about 3 segments long with about 30 rows of muscle cells; inferior simple setae of *B. gallagheri* have bidentate tips, while those of *B. wellfleetensis* are unidentate; and sperm and eggs begin in setigers 15–18 and notoacacula and natatory setae begin in setigers 18–21 of *B. gallagheri*, while sexual products, natatory setae and notoacacula begin in setigers 12–14 of *B. wellfleetensis*.

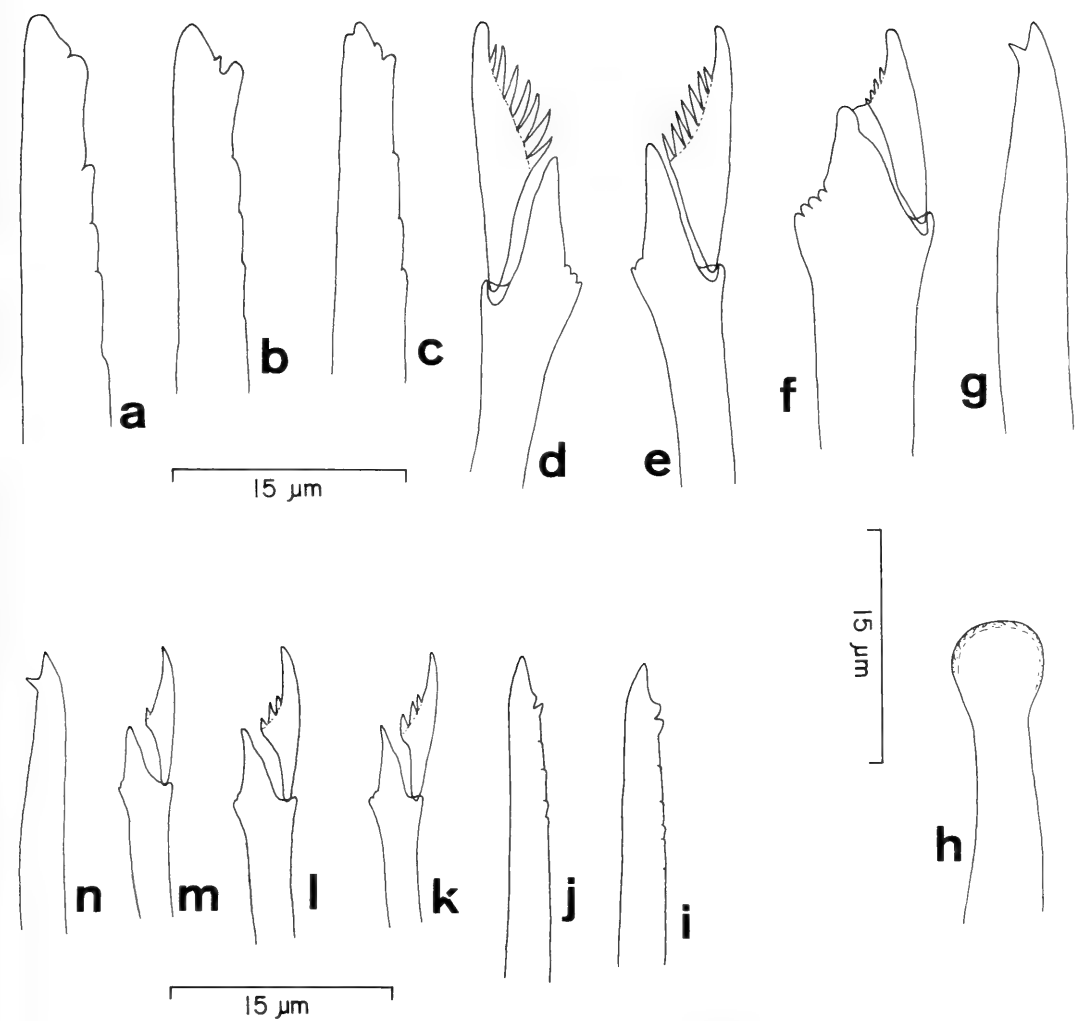


Fig. 3. *Brania gallagheri*: a–c, Superior simple setae, middle segments; d, Upper compound seta of setiger 37; e, Middle compound seta of same; f, Lower compound seta of same, blade somewhat turned; g, Inferior simple seta of posterior setiger; h, Aciculum of setiger 37; i, j, Superior simple setae, posterior setigers of juvenile; k, Upper compound seta of same; l, Middle compound seta of same; m, Lower compound seta of same; n, Inferior simple seta of same (a–h, USNM 54502; i–n, FSBC I 20584).

*Etymology*.—The species is named in honor of Mr. Robert M. Gallagher, who was instrumental in providing the excellent specimens from the Hutchinson Island study.

*Dioplosyllis* Gidholm, 1962  
*Dioplosyllis octodentata*, new species  
Fig. 4

*Material examined*.—FLORIDA: Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher,

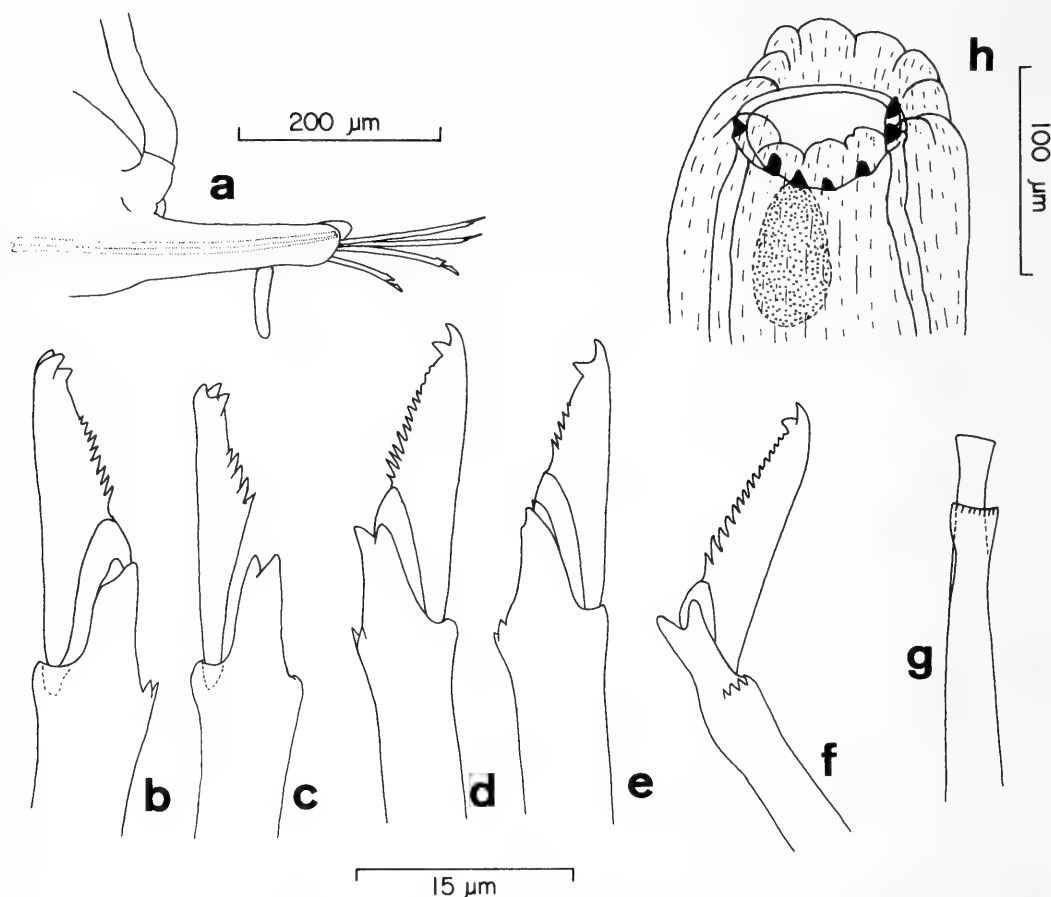


Fig. 4. *Dioplosyllis octodentata*: a, Posterior parapodium, posterior view; b-e, Compound setae of same: b, Upper; c, Upper middle; d, Lower middle; e, Lower; f, Compound seta, oblique view; g, Acicula, anterior parapodium; h, Tip of pharynx, ventral view, teeth darkened, midventral tooth obscuring tip of middorsal tooth which is outlined by dashed line and stippled (FSBC I 23501).

col., Nov. 1972; USNM 54509), 2 paratypes (FSBC I 23500, 23501). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 1 paratype (USNM 54508). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 1 paratype (FSBC I 23502).

*Description*.—Holotype, largest adult specimen, incomplete posteriorly, in 2 pieces, 8 mm long, 0.5 mm wide without parapodia, with about 50 setigerous segments; complete juvenile relatively long, slender, with about 35 setigers. Prostomium pentagonal, about twice as wide as long, with pointed anteromedial lobe comprising anterior half; sides of lateral half rounded; posterior edge convex, with very slight medioposterior notch. Antennae on short ceratophores, lengths 3–5 times prostomial width, median slightly longer; laterals originating from sides of anteromedial lobe; median originating between posterior eyes. Palps longer than prostomial lobe, stouter

distally, probably free to base. Eyes 3 pairs; 2 pairs on posterior half in trapezoidal arrangement open to front, lensed; anterior eyespots medial to origins of lateral antennae. Nuchal organs on posterior part. Tentacular segment slightly narrower than following segment; tentacular cirri 2 pairs, on short cirrophores, similar to dorsal cirri of following segments. Transverse rows of cilia on ventrum and on dorsal and ventral borders of parapodial lobes on setigerous segments; cilia apparently not extending across dorsum. Dorsal cirri without obvious regular arrangement of alternating lengths, 2–3 mm long. Parapodial lobes (Fig. 4a) as long as body width, with 6–8 falcigerous compound setae in anterior segments and 4–5 in posterior segments. Ventral cirri attached near middle of ventral margins of parapodial lobes, extending about to tips. Shafts of compound setae (Fig. 4b–e) with pronounced bifurcation on tips, with transverse row of serrations below tips. Upper compound setae with stout shafts; lower compound setae with shafts similar in diameter to those in middle of bundle and not as thick as upper shafts; blades of compound setae stoutest in upper parts, longest in middle, shortest in lower parts of bundle; tips of blades tridentate, with principal tooth bifurcate in plane perpendicular to blade (Fig. 4b, c). Solitary, slender, bidentate, superior simple setae on posterior setigers of 2 small, complete specimens; principal tooth longer than secondary, strongly falcate. Two acicula in anterior parapodia (Fig. 4g); solitary aciculum in posterior parapodia.

Pharynx usually in first 7 setigers in adults, proventriculus in setigers 8–12 or 14; pharynx and proventriculus in more anterior segments of smaller specimens. Pharynx slightly less than  $1\frac{1}{2}$  times longer than proventriculus; tip armed with large, middorsal tooth and ventral arc of 7 smaller teeth (Fig. 4h); rim otherwise smooth in figured specimen but appearing indistinctly scalloped in holotype (however, pharynx of latter somewhat contorted, not allowing satisfactory illustration). Proventriculus with about 33 rows of muscle cells including 10 small rows anterior to chitinous ring.

*Remarks.*—Differences among species of *Dioplosyllis* were recently tabulated by Mueller and Fauchald (1976). *D. octodentata* is closely allied with *D. cirrosa* Gidholm (1962:253–255) from the Atlantic coast of France. *D. octodentata* differs from *D. cirrosa* in the following characters. The pharynx of *D. octodentata* has a ventral arc of 7 small teeth on the edge while the pharynx of *D. cirrosa* has a ventral arc of 5 small teeth with tips removed from the edge. Anterior eyespots are present on the prostomium of *D. octodentata* and absent on *D. cirrosa*. The length of the pharynx compared with the length of the proventriculus of *D. octodentata* is 1.5:1 while the pharynx of *D. cirrosa* is almost twice as long as the proventriculus. The proventriculus of *D. octodentata* has about 33 rows of muscle cells while that of *D. cirrosa* has 45. Shafts of compound setae of *D. octodentata* are



distally much more deeply notched than those of *D. cirrosa*, and the 3 teeth on tips of blades are much larger.

Specimens of *D. octodentata* may be easily misidentified as *Eusyllis lamelligera* Marion and Bobretzky, 1875, since both species have long dorsal cirri and a pharynx with a denticulate margin. [Pettibone (1963:120–122) referred both *Syllis fragilis* Webster (1879:217–220, pl. 4, figs. 42, 43) and *Eusyllis tenera* Verrill (1882:368) to *E. lamelligera*.] However, palps of *E. lamelligera* are fused for about a third of their dorsal length, and the details of the setae of the 2 species are greatly different.

*Etymology*.—The specific name, derived from the Latin adjectives, *octo*, meaning eight, and *dentata*, meaning toothed, refers to the number of pharyngeal teeth.

*Exogone* Örsted, 1845

*Exogone dispar* (Webster, 1879)

*Paedophylax dispar* Webster, 1879:223, pl. 4, fig. 49, pl. 5, figs. 50–55.

*Exogone dispar*.—Pettibone, 1963:130, fig. 35d (synonymy) [in part; not *Paedophylax longicirris* Webster and Benedict].—Taylor, 1971:201–204 [in part].—Hall and Saloman, 1975:12 [list; in part].—Day, 1973:33, 34 [in part; not *E. clavator* Ehlers and *E. uniformis* Hartman].—Westheide, 1974:106–109, figs. 48, 49 [in part; not Hartman and Fauchald, 1971, mixture of species; not Kohn and Lloyd, 1973].—Gardiner, 1976:132, fig. 11f–i [in part].

*Material examined*.—4 specimens on slides, from Webster's private collection identified as *Paedophylax dispar*, now deposited at Smithsonian Institution, without locality data but probably type-specimens from Virginia (USNM 27560). NEW JERSEY: Great Egg Harbor; numerous specimens (USNM 495, 498; as *Paedophylax dispar* by Webster). NORTH CAROLINA: Cape Lookout; S. Gardiner and H. Wilson, cols. (USNM 52918, 52919). Off Beaufort, J. H. Day, col., 16 specimens (USNM 51072). FLORIDA: Lower Tampa Bay, 27°36'56"N, 82°41'05"W, 9 m, J. Taylor and C. Saloman cols., 25 Oct. 1963; 79 specimens (USNM 60478).

*Description*.—Long, slender, at most about 5 mm long, with up to 40 segments. Median antenna long, club-shaped, extending about to tips of palps; lateral antennae papilliform; 4 eyes. Proventriculus cylindrical, shorter than pharynx, with 17–20 rows of muscle cells, in 2–3 segments beginning in setiger 4 when pharynx inverted. Dorsal cirri on all setigers. Obscure oblate, subdermal gland below dorsal cirrus of each parapodium. Setae including superior and inferior simple setae, compound spinigers and falcigers. Superior simple setae of middle segments strongly bent near tips; tips pointed, smooth or irregularly dentate on outer edges below tips, without spines or aristae. Spinigers similar throughout body, with shafts slightly enlarged

near tips and spinous; blades shorter on posterior segments. Falcigers with bidentate blades, primary tooth much smaller than secondary, serrate on anterior segments, shorter, without serrations on posterior segments. Inferior simple setae on posterior parapodia, with bidentate tips, secondary tooth smaller than primary. Pygidium with 2 cirri. Sexually mature specimens with natatory setae beginning on setiger 14 or 15; eggs and sperm often found in more anterior segments, e.g., setiger 10.

*Remarks.*—The synonymy of the species is complicated. *Exogone longiceps* (Verrill, 1879) and *E. dispar* were described at about the same time. Verrill was aware of Webster's species and differentiated *E. longiceps* from *E. dispar* on rather questionable characters. Types of *E. longiceps* have apparently been lost, but it appears very similar if not identical with *E. dispar* (Pettibone, 1963). Pettibone (1954, 1963) also included *E. longicirris* (Webster and Benedict) in synonymy with *E. dispar*; *E. longicirris* is a different species. Day (1973) included *E. clavator* Ehlers from South Africa and *E. uniformis* Hartman from California in synonymy with *E. dispar*. However, according to Day (1967) spinigerous compound setae are absent from posterior segments of *E. clavator*; they are present on posterior segments of *E. dispar*; and according to Banse (1972), *E. uniformis* has a long proventriculus "with 26 or 27 rows of muscular columns" extending through 7–8 setigers, a short median antenna (Banse, 1972:201, fig. 5e) and setae which are similar to *E. lourei* Berkeley and Berkeley.

Specimens reported as *E. dispar* from Alaska by Pettibone (1954) apparently included 2 species. One of the species had superior simple setae with an arista and is possibly *E. longicirris*; the other species may be *E. lourei*, which she included in her synonymy. The same type of aristate superior simple seta was described by Kohn and Lloyd (1973) for specimens from Easter Island referred to *E. dispar*.

In Atlantic areas, specimens reported as *E. dispar* by Hartman (1965) and Hartman and Fauchald (1971) are apparently a mixture of species and should be re-examined. Specimens reported as *E. dispar* by Taylor (1971) from Tampa Bay, Florida, include both *E. dispar* and *E. arenosa*, n. sp. About half of the specimens from Bogue Sound and Banks Channel, North Carolina (USNM 52916, 52917), reported as *E. dispar* by Gardiner (1976), are similar to *E. arenosa*, n. sp., in having enlarged shafts of spinigers on setiger 2, but the shafts differ in shape from those of *E. arenosa*. The specimens are similar to *E. dispar* in having superior simple setae without spines on the tips and the proventriculus of mature specimens with about 20 rows of muscle cells. All of Gardiner's (1976) specimens from Cape Lookout (USNM 52918, 52919) are typical examples of *E. dispar*.

I can confirm the presence of the species on the east coast of North America from Massachusetts to Florida and the Gulf of Mexico and from the Galapagos Islands in the eastern Pacific Ocean.

*Exogone longicirris* (Webster and Benedict, 1887)

Fig. 5a-f

*Paedophylax longicirris* Webster and Benedict, 1887:722, pl. 3, figs. 46-50.  
*Exogone dispar*.—Pettibone, 1954:259; 1963:130-131 [in part; not *Paedophylax dispar* Webster].

*Material examined*.—MAINE: Eastport; 4 syntypes (USNM 439).

*Description*.—Slender, up to about 3 mm long and 0.3 mm wide. Median antenna long, cylindrical, extending almost to tips of palps, lateral antennae about  $\frac{1}{4}$  as long; 4 eyes. Proventriculus cylindrical,  $\frac{2}{3}$  as long as pharynx with about 11 large and 5 small rows of muscle cells; in length of 3 segments beginning in setiger 4 or 5; pharynx light-colored, about 5 segments long. Dorsal cirri on all setigers. Setae including superior and inferior simple setae, compound spinigers and falcigers. Superior simple setae on middle and posterior parapodia (Fig. 5a, b), with 2 subequal teeth on tips, with arista beginning below tips on concave edge and extending beyond. Spinigers (Webster and Benedict, 1887:pl. 3, fig. 48) similar throughout body, shorter posteriorly. Blades of falcigers (Fig. 5c, d) with similar primary and secondary teeth, with arista or hood beginning at bases and extending to near tips. Inferior simple setae on posterior parapodia (Fig. 5e), similar to superior simple setae but with shorter aristae and sharper teeth. Acicula (Fig. 5f) solitary, with knobbed tips. Pygidium with 3 anal cirri.

*Remarks*.—*Exogone longicirris* differs from *E. dispar* (Webster) in having bidentate superior and inferior simple setae which are also aristate and in having compound falcigers with hooded blades. I cannot determine from examination of the types that compound spinigers are present on posterior setigers. There are no posterior segments on the syntypes I examined, and most setae of middle segments are broken.

*Exogone lourei* Berkeley and Berkeley, 1938

*Exogone lourei* Berkeley and Berkeley, 1938:44, figs. 6-12; 1948:79, fig. 117.—Berkeley, 1967:1055.—Pettibone, 1967:5.—Banse and Hobson, 1968:16, fig. 4d, e.—Banse, 1972:200-202, figs. 5a-d; 1974:58, figs. 14h-j.  
*Exogone uniformis* Hartman, 1961:73, 74 [in part; pl. 6, fig. 1, pl. 7, fig. 1 and 8 specimens from type-locality, but not holotype (AHF Poly 0170) or paratypes (AHF Poly 0171), fide Banse (1972)]; 1968:427, 428 [in part; unnumbered figures of anterior and posterior ends].

*Material examined*.—BRITISH COLUMBIA: False Narrows; holotype (USNM 32895). WASHINGTON: Puget Sound, 47°41'33"N, 122°24'18"W, 23 m (16-36), Sta. 1 of Banse and Hobson (1968); 27 Feb. 1963; 1 specimen (USNM 36538).

*Description*.—Slender, up to about 8 mm long with about 50 segments.

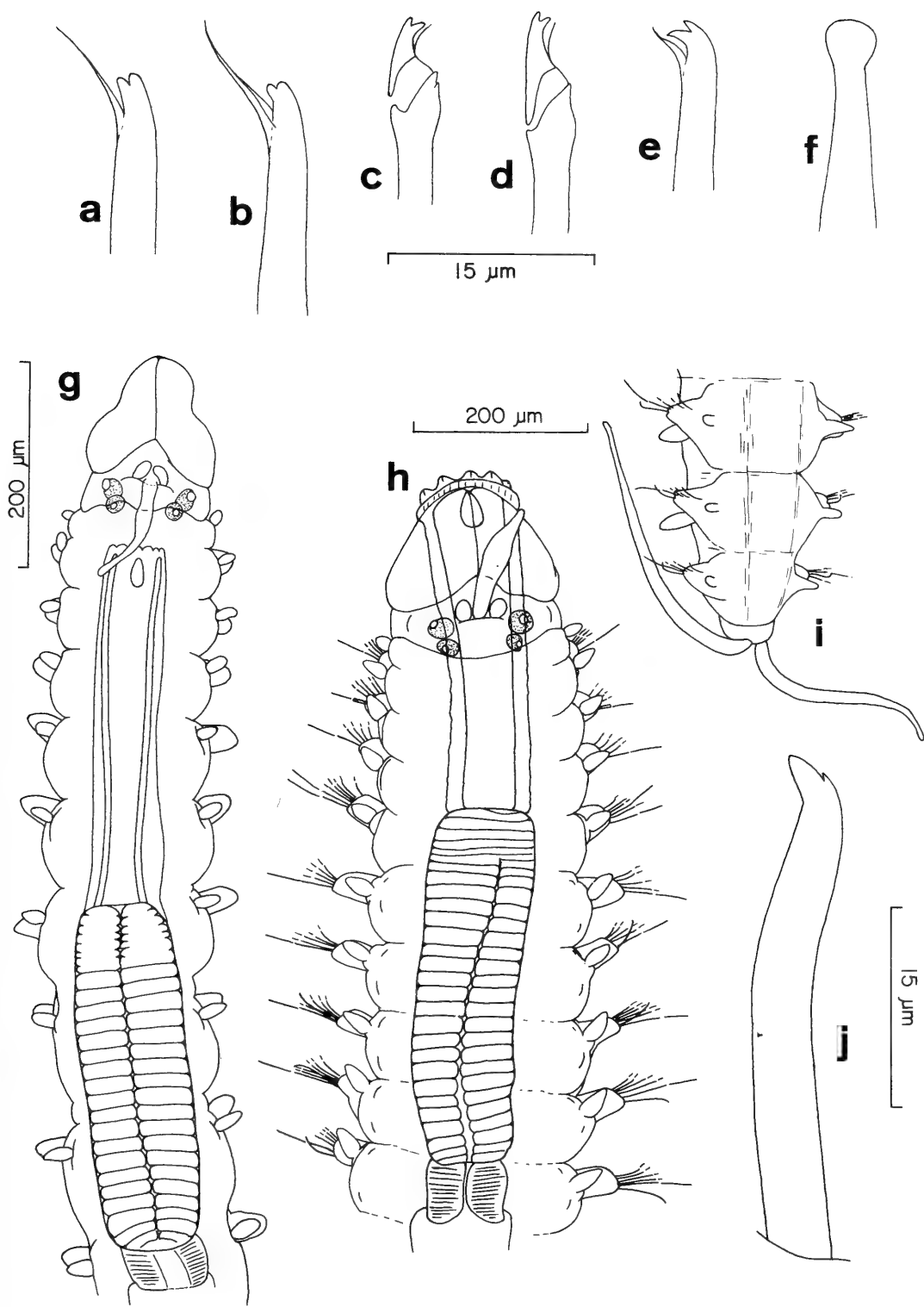


Fig. 5. *Exogone longicirris*: a, b, Superior simple setae; c, d, Compound falcigers; e, Inferior simple seta; f, Aciculum. *Exogone arenosa*: g, Anterior end, relaxed specimen; h, Same, contracted specimen (FSBC I 23522); i, Posterior end, ventral view; j, Inferior simple seta (FSBC I 23516).

Median antenna long, nearly reaching to anterior ends of palps; lateral antennae short, ovoid; 4 eyes. Proventriculus cylindrical, shorter than pharynx, with about 20 rows of muscle cells on mature specimens, in length of 3 or 4 segments beginning in setiger 3 or 4; pharynx dark red, with tip rolled backwards when everted. Dorsal cirri on all setigers. Setae including superior and inferior simple setae, compound spinigers and falcigers. Superior simple setae beginning on anterior setigers, strongly bent near tips; tips pointed; irregularly dentate on outer edges below tips but without spines or aristae (Banse and Hobson, 1968:fig. 4d). Spinigers of setiger 2 enlarged, with large, triangular process below tip of shafts and tongue-shaped process on one side of tip, with blades shorter than on setiger 1 or 3 (Banse, 1972:fig. 5b). Spinigers continuing to posterior end but gradually shorter. Falcigers (Banse and Hobson, 1968:fig. 4e) bidentate, with secondary tooth much larger than primary, serrate on edge on anterior setigers, slightly shorter and without serrations posteriorly. Inferior simple setae on middle and posterior segments, sigmoid, tips bidentate with primary tooth much smaller than secondary. Pygidium with 2 anal cirri. Natatory setae, sperm, 2 ova or embryos per segment beginning on about setiger 17 and extending to about setiger 35.

*Exogone uniformis* Hartman, 1961

*Exogone uniformis* Hartman, 1961:73, 74 [in part, not pl. 6, fig. 1, pl. 7, fig. 1 and 8 specimens from type-locality, fide Banse, 1972]; 1968:427, 428 [in part, not unnumbered figures of anterior and posterior ends].—Banse, 1972:202, 203, fig. 5e [diagnosis and additional description based on examination of holotype (AHF Poly 0170) and 3 paratypes (AHF Poly 0171)].

*Remarks.*—Both Hartman's (1961) description and material of *E. uniformis* included *E. lourei* Berkeley and Berkeley; however, the 2 species differ as diagnosed by Banse (1972). Also see remarks under *E. dispar* and *E. arenosa*.

*Exogone arenosa*, new species

Figs. 5g–j, 6

*Exogone dispar.*—Taylor, 1971:201–204.—Hall and Saloman, 1975:12 [list] [in part, not *Paedophylax dispar* Webster, 1879].

*Material examined.*—FLORIDA: Hutchinson Island Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Jan. 1972; USNM 60442), 54 paratypes (USNM 60443; AHF Poly 1308, 1309; ZMH P-16389; FSBC I 23503–23511). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 17 paratypes (ZMH P-16390; FSBC I

23512–23516). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 10 paratypes (FSBC I 23517–23523). Palm Beach, 0.5–0.75 mi off Breakers Hotel, "Breakers Reef," 26°42.8'N, 80°01.2'W, 23.7 m; J. W. Smith *et al.*, cols., Mar. 1976; 1 paratype (FSBC I 23524). Tampa Bay, 27°36'56"N, 82°41'05"W, 9 m, sand; J. Taylor and C. Saloman, cols., 25 Oct. 1963; 170 paratypes (USNM 60444).

*Description.*—Tube mucoid, covered to some extent with sand. Body without color markings; eyes light to dark red, rarely black. Well-preserved, sexually mature specimens mostly 5–6 mm long, about 0.25 mm wide, about 50 setigerous segments. Prostomium (Fig. 5g, h) about twice as wide as median length; anteromedian part forming rounded, obtuse angle; lateral sides rounded; posterior side often covered by fold of tentacular segment. Two pairs of lensed eyes on posterior part in about middle and in contact on each side; anterior pair slightly larger, more lateral. Long, fusiform median antenna originating about middle of prostomium, extending anteriorly to near tips of palps; papilliform lateral antennae originating between base of median antenna and anterior pair of eyes; all antennae on slight prominence of prostomium. Palps together slightly wider than prostomium, slightly longer than median prostomial length, with anterior notch and median dorsal furrow. Tentacular segment slightly wider than prostomium, about half length of following segments, with pair of small, ovoid tentacular cirri on anterolateral margins. Small, pyriform or papilliform dorsal cirri on all setigers of almost all specimens; few juvenile specimens (FSBC I 23525) with dorsal cirri absent from setiger 2; cirri well above parapodia, usually shorter than parapodial lobes. Parapodial lobes stout, truncate, distally bilabiate. Ventral cirri slightly flattened, smaller than but otherwise similar to dorsal cirri, originating on ventral median parts of parapodial lobes. Solitary, superior simple setae (Fig. 6b, c) with long, thin secondary spine near tips, beginning on first setiger of juveniles, on more posterior setigers of larger specimens (setiger 1–15), not as thick as shafts of compound setae on anterior segments, becoming much stouter on posterior segments. Compound setae (Fig. 6a, d–g) both spinigerous and falcigerous. Spinigers 1, occasionally 2, in upper parts of bundles. Spinigers of setiger 2 (Fig. 6a, d) with stout shafts having single, large, stout, triangular process below tips on same side as pectinate edges of blades and tooth on one side of tips; blades 30–43  $\mu\text{m}$  long. Shafts of spinigers of remaining segments (Fig. 6e) without triangular process. Spinigerous blades of setiger 3 always longer than those of setiger 2, 38–49  $\mu\text{m}$  long; blades 26–30  $\mu\text{m}$  long at posterior end. Falcigerous blades bidentate, with secondary tooth much stouter than primary, numbering 6–7 on anterior parapodia, 3–4 on median parapodia, 2–3 on posterior parapodia, about 10  $\mu\text{m}$  long on anterior segments with about 6 long serrations below secondary tooth, shorter posteriorly, 6  $\mu\text{m}$  or less in length and smooth below secondary tooth. Solitary, bidentate, inferior simple setae

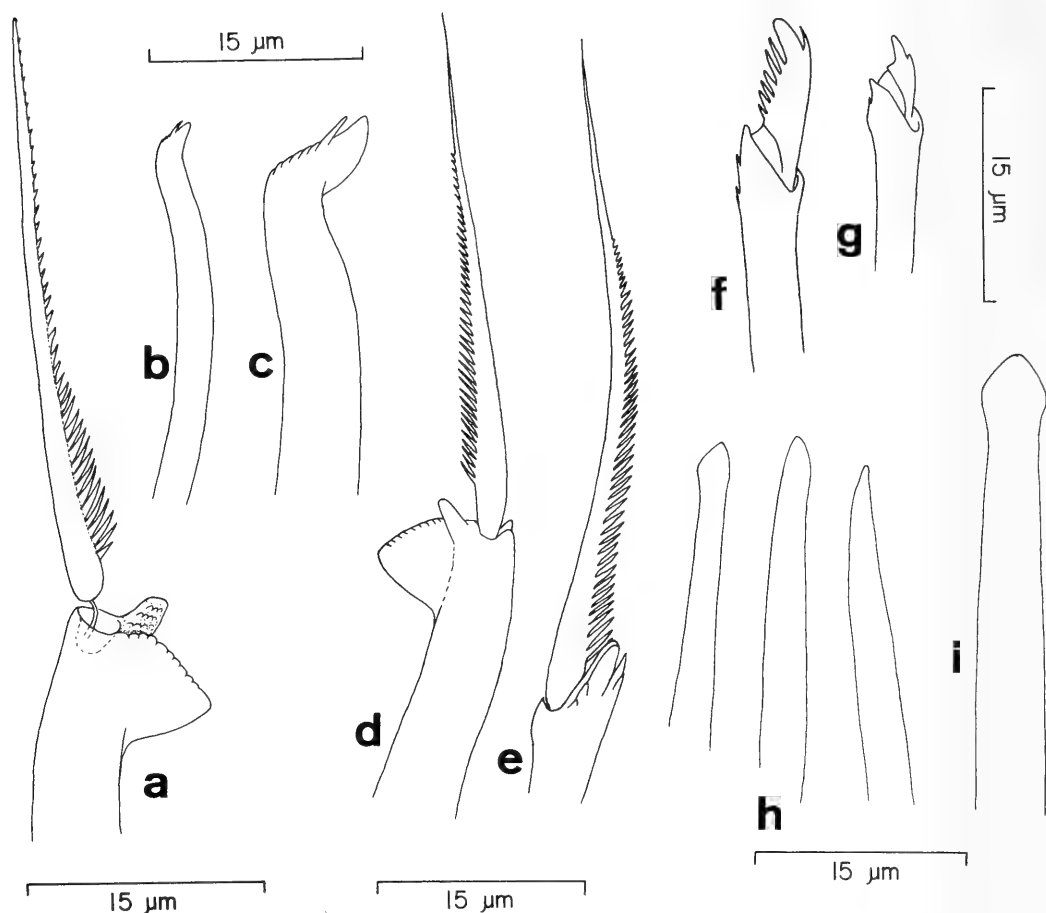


Fig. 6. *Exogone arenosa*: a, Spiniger with stout, triangular process on shaft, setiger 2; b, Superior simple seta, setiger 10; c, Same, posterior setiger; d–g (FSBC I 23516): d, Spiniger with stout, triangular process on shaft, setiger 2; e, Spiniger without stout triangular process on shaft, setiger 3; f, Falciger, setiger 2; g, Falciger, setiger 49; h, Acicula, setiger 3; i, Aciculum, posterior setiger.

(Fig. 5j) on last 16 setigers of large specimen, on posterior 5–7 segments of most specimens. Three acicula in anterior parapodia; solitary, much stouter one in posterior parapodia (Fig. 6h, i). Pygidium (Fig. 5i) rounded, with pair of anal cirri about as long as last 3 setigerous segments. Sexually mature males with natatory setae beginning on setiger 19–20 for maximum of 22 segments; sperm mostly beginning on segment anterior to that on which natatory setae begin, extending to 1–2 segments anterior to segment having posteriormost natatory setae. External embryos 2 per segment, attached to median side of ventral cirri of some females beginning on setiger 19–20, continuing for 15–19 segments; natatory setae absent on females with external embryos, occasionally found on more immature specimens. Approximately last 10 segments lacking sex products or natatory setae.

Pharynx relatively thin walled, with large, anterior middorsal tooth; anterior end surrounded by 10 soft papillae; wall surrounded by brownish glands. Location of pharynx depending upon state of contraction, usually in first 5 setigerous segments of relaxed specimens, extending from anterior of palps to posterior part of setiger 3 of contracted specimens. Proventriculus about equal in length to pharynx, cylindrical, slightly greater than 3 times longer than diameter, with 25–28 rows of muscle cells with anterior 6 rows small in sexually mature adults, with fewer rows of muscle cells, e.g., 12 large and 6 small rows in juveniles. Posterior part of proventriculus usually extending to anterior part of setiger 9 with well-defined ventricle in same.

*Remarks.*—*Exogone arenosa* differs from *E. dispar* Webster in having shafts of spinigers of setiger 2 enlarged with a large triangular process near the tips, in having a longer proventriculus and in having superior simple setae with a spine on the tips. *E. arenosa* is very similar to *E. lourei* Berkeley and Berkeley from the northeast Pacific; compound setae of the 2 species appear identical. However, superior simple setae of *E. arenosa* differ from those of *E. lourei* in having a well-defined spine on the tips, and the proventriculus of *E. arenosa* is longer with up to 28 rows of muscle cells while that of *E. lourei* has about 20 rows of muscle cells. The compound setae and proventriculus of *E. uniformis* Hartman, 1961, are similar to those of *E. arenosa*. *E. uniformis* has a shorter median antenna and superior simple setae apparently do not have a spine on the tips (cf. Banse, 1972:203).

*Etymology.*—The specific name is derived from Latin and refers to the sandy tube.

*Exogone atlantica*, new species

Fig. 7

*Material examined.*—FLORIDA: Eastern Gulf of Mexico off Egmont Key, Project Hourglass Sta. C, 27°37'N, 83°28'W, 37 m, in scleractinian *Siderastrea radians* (Pallas, 1766); R/V *Hernan Cortez*, B. Presley, col., 13 Dec. 1966; holotype (USNM 60345). Same, Project Hourglass Sta. B, 27°37'N, 83°07'W, 18 m; 3 Apr. 1967; 2 paratypes (FSBC I 23526). Same, off Sanibel Island, Project Hourglass Sta. L, 26°24'N, 83°22'W, 55 m; 15 Nov. 1967; 1 paratype (USNM 60346). Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 5 paratypes (AHF Poly 1310; ZMH P-13191; FSBC I 23527–23529).

*Description.*—Pharynx reddish brown, surrounded by thin, brownish glands. Maximum length 3.2 mm, 38 setigerous segments; body anteriorly tapered for first few segments, gradually tapered posteriorly. Prostomium (Fig. 7a) longer than wide. Three pairs of eyes; anterior pair small, apparently lensed, on margin anterior to lateral antennae, remaining 2 pairs larger,



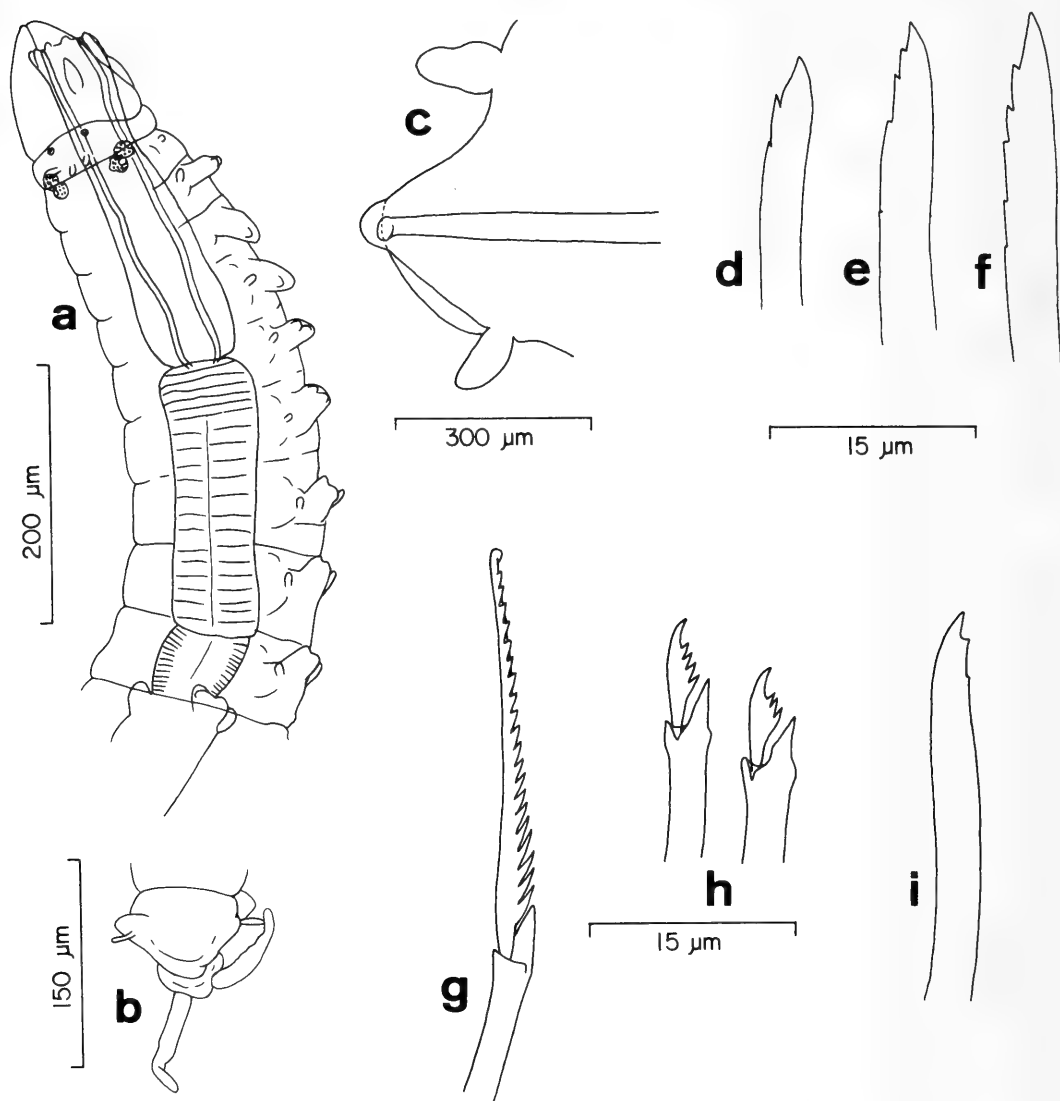


Fig. 7. *Exogone atlantica*: a, Anterior end of holotype, left lateral antenna partially obscuring lateroanterior, lensed eye; b, Posterior end, ventral view; c, Parapodium, anterior setiger, posterior view (FSBC I 23527); d-f, Superior simple setae: d, Setiger 12; e, Middle setiger; f, Posterior setiger; g, Spiniger, anterior setiger (FSBC I 23527); h, Upper and lower falcigers of same; i, Inferior simple seta.

lensed, on posterior part of prostomial lobe, arranged as flattened trapezoid open to front, partially covered by fold of tentacular segment. Three minute antennae between anterior pair of large eyes. Palps slightly narrower and about as long as prostomial width, subtriangular, with small anterior notch and dorsal furrow. Tentacular segment visible dorsally, anteriorly forming fold covering posterior part of prostomium; length similar to following segments; width intermediate between those of prostomium and setiger 1. Single pair of minute tentacular cirri smaller than antennae and dorsal cirri on

lateral sides. Dorsal cirri absent from setiger 2, short, somewhat oval in outline on other segments, originating well above parapodial lobes. Ventral cirri about same length but more slender than dorsal cirri, originating on median ventral edges of parapodial lobes, often longer on posterior than on anterior segments. Solitary, superior simple setae (Fig. 7d–f) on all parapodia, with acute tips, coarsely serrate near tips with 2–5 pointed teeth on edge. Upper compound setae (Fig. 7g) solitary spinigers, occurring only on anterior half of body on 2 specimens, on all but posterior 4–10 setigers of others; blades of spinigers long, thin, tips rounded or slightly hooked, finely serrate on edge, about half as long on posterior as in anterior segments; shafts thin, with distal part acutely tipped, broad at socket of blade. Falcigers (Fig. 7h) 3–4 in each parapodium; shafts stouter than those of spinigers; all blades similar, delicate, slightly falcate, unidentate, almost as wide and less than twice as long as shaft width, with up to 4 coarse serrations on edge. Solitary, inferior simple setae on posterior segments (Fig. 7i), with acute tips, with 1, occasionally 2, pointed secondary teeth on concave side near tips. Acicula solitary; tips slightly enlarged, bent forward. Pygidium (Fig. 7b) with pair of long, slender anal cirri. One somewhat damaged sexually mature specimen with sex products in setigers 11–28; gravid segments with bundles of about 10 short, very fine, natatory setae between parapodia and dorsal cirri.

Pharynx long, extending posteriorly to setiger 4–6. Middorsal tooth relatively large, anterior; anterior end surrounded by about 10 soft lobes. Proventriculus narrow, cylindrical, in setigers 4–6 to 7–8, with 17–20 rows of muscle cells, anterior 5–6 small; prominent ventricle in setiger 8 or 9. Relative lengths of pharynx and proventriculus 1:0.8.

*Remarks.*—*Exogone atlantica* is similar to *E. microtentaculata* Westheide (1974:121–123, figs. 51a–d, 56) from the Galapagos Islands, but differs in the relative lengths of the pharynx and proventriculus, in shapes of superior and inferior simple setae and possibly in the shape of acicular tips.

*Etymology.*—The specific name refers to the type-locality of this species as opposed to that of the closely related tropical Pacific species, *E. microtentaculata* Westheide.

*Odontosyllis* Claparède, 1863

*Odontosyllis longigulata*, new species

Fig. 8

*Material examined.*—FLORIDA: Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., May 1972; USNM 60445), 13 paratypes (USNM 60447; ZMH P-16392; FSBC I 23530–23536). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 13 paratypes (USNM 60446; AHF Poly 1311; FSBC I 23537–23544).

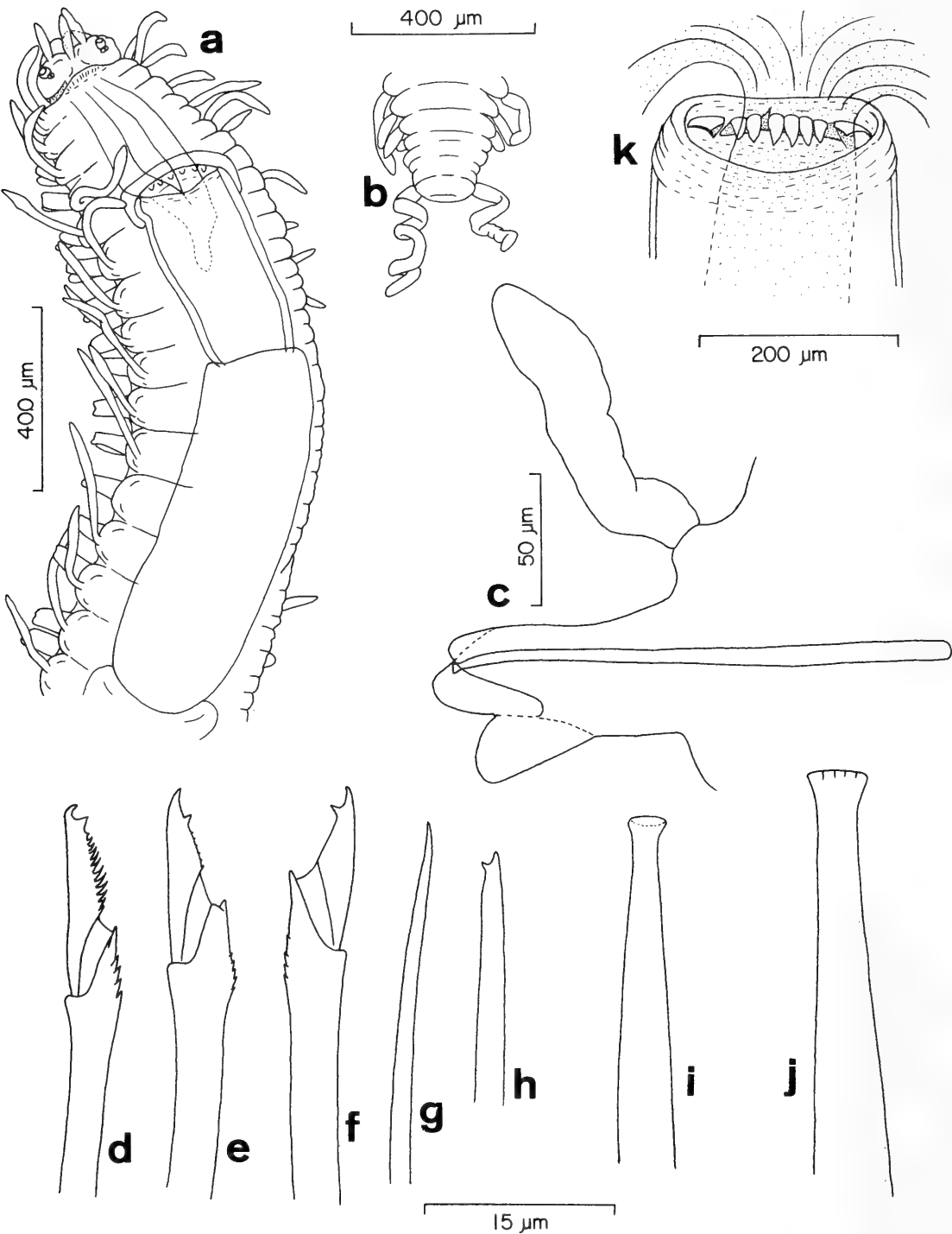


Fig. 8. *Odontosyllis longigulata*: **a**, Anterior end, dorsal view (FSBC I 23532); **b**, Posterior end of holotype, dorsal view; **c**, Parapodium, slightly turned, anterior view; **d-j** (AHF Poly 1311): **d**, Upper falciger, setiger 10; **e**, Lower falciger of same; **f**, Falcigers, posterior setigers; **g**, Superior simple seta of same; **h**, Inferior simple seta of same; **i**, Aciculum, setiger 10; **j**, Same, posterior setiger; **k**, Anterior border of pharynx, dorsal view (FSBC I 23532).

*Description.*—Body without color markings; pharynx often dark reddish brown. Maximum length about 6.5 mm with maximum of about 50 segments. Prostomial lobe oval, about twice as wide as long, posteriorly notched. Two pairs of lensed eyes in trapezoidal, almost rectangular, arrangement, anterior pair larger. Three short, similar, club-shaped to fusiform antennae, about half as long as prostomial width; median originating from about middle of prostomial lobe; laterals originating on anterolateral margin between anterior pair of eyes; all generally directed upward. Ciliated nuchal organs posterior to eyes on curved lateral parts of prostomium. Palps basally fused, free tips usually bent ventrally. Tentacular segment visible dorsally only as short, anteriorly rounded, nuchal fold (Fig. 8a). Tentacular cirri generally directed ventrally. Dorsal tentacular cirri slightly longer than ventral; ventral tentacular cirri slightly longer than antennae. Setigerous segments strongly arched dorsally, flattened ventrally. Dorsal cirri club shaped to fusiform on anterior segments, fusiform posteriorly, about twice as long as antennae on setiger 1; short,  $\frac{1}{2}$  to  $\frac{1}{3}$  body width without parapodia behind first few segments. Parapodial lobes (Fig. 8c) relatively slender. Ventral cirri originating near tips of parapodial lobes, appearing slightly compressed, extending laterally about to tips; ventral margins forming line about  $30^\circ$  from aciculum. Only bidentate compound setae on anterior parapodia, joined by solitary superior and inferior simple setae on posterior parapodia. Superior simple setae (Fig. 8g) smooth, slender, slightly curved, unidentate. Blades of upper compound setae of anterior parapodia (Fig. 8d) with tips strongly falcate, with large secondary tooth below primary; blade edges pectinate, with about 12 long serrations. Distal ends of shafts of upper compound setae of anterior parapodia strongly serrate. Blades of lower compound setae of anterior parapodia shorter, stouter than upper blades, with primary teeth not as falcate, and secondary teeth not as stout, with about 6, short serrations on blade edges. Shafts of lower compound setae of anterior parapodia (Fig. 8e) slightly stouter than dorsal; distal ends bifid, with about 5 small serrations below tips. All compound setae of posterior segments similar; blades with long, pointed, only slightly falcate primary tooth, secondary tooth short, triangular, otherwise smooth. Inferior simple setae (Fig. 8h) slender, half as thick as shafts of compound setae; tips bidentate, similar in shape but smaller than blade tips of compound setae. Acicula (Fig. 8i, j) solitary, about twice as stout in posterior parapodia, slightly enlarged near tips, truncate. Pygidium (Fig. 8b) with long, helically curved anal cirri; length of cirri of 1 specimen equal to that of posterior 10–12 segments.

Pharynx long, thin walled, in setigers 2–7 to 5–9 (5–6 segments), with long dorsal projection at entrance; trepan (Fig. 8k) with ventral row of about 6 teeth and 2 lateral plates. Proventriculus long, in setigers 8–9 to 15 (7–8 segments), with 60–70 rows of muscle cells. Length ratio of pharynx to proventriculus 1:1.8.

*Remarks.*—*Odontosyllis longigulata* is superficially similar to *O. undecimdongta* Imajima and Hartman (1964:114, pl. 26, figs. h, i, pl. 27, figs. a–e) from Japan in having a short, rounded nuchal fold, short antennae and dorsal cirri, bidentate compound setae, superior and inferior simple setae, and blunt-tipped acicula. *O. undecimdongta* is a larger species, 20 mm long and 2 mm wide with 120 setigerous segments, the nuchal fold is larger, the pharynx has 11 teeth, and parapodia are much stouter than those of *O. longigulata*.

*Etymology.*—The specific name, derived from Latin, refers to the long pharynx.

*Parapionosyllis* Fauvel, 1923

*Parapionosyllis longicirrata* (Webster and Benedict, 1884)

Fig. 9

*Sphaerosyllis longicirrata* Webster and Benedict, 1884:715, 716, pl. 8, figs. 95–100.

*Pionosyllis manca* Treadwell, 1931:1, 2, fig. 1.

*Parapionosyllis longicirrata*.—Pettibone, 1963:132, fig. 35e–f.—Day, 1973:32.—Gardiner, 1976:133, fig. 11o–r.

*Material examined.*—MASSACHUSETTS: Orleans, Cape Cod; Pettibone, col., 25 Aug. 1954; 2 specimens (USNM 27522). Provincetown, Cape Cod, muddy sand; Pettibone, col., 29 Aug. 1954; 1 specimen (USNM 32519). VIRGINIA: Off Cape Henry, 38 m, bottom net, USFC *Fish Hawk* Sta. 8835, 1 paratype of *Pionosyllis manca* Treadwell (USNM 19600). NORTH CAROLINA: Off Beaufort, 34°34'N, 76°25'W, 20 m, sand and broken shell; 4+ specimens (USNM 51070). FLORIDA: Hutchinson Island Sta. I, 27°21.3'N, 80°14.1'W, about 8 m, very fine to fine quartose sand; 1 specimen (FSBC I 20795). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 10 specimens (FSBC I 20612–20621). Sta. III, 27°22.0'N, 80°12.4'W, about 7 m, medium calcareous sand; 21 specimens (FSBC I 20622–20633). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 15 specimens (USNM 54517; FSBC I 20634–20645). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 35 specimens (USNM 54516, 54518; FSBC I 20646–20657, 20659–20661). Palm Beach, 0.5–0.75 mi off Breakers Hotel, "Breakers Reef," 26°42.8'N, 80°01.2'W, 23.7 m, in galleries of fossil coral; J. W. Smith *et al.*, cols., 3 March 1976; 1 specimen (FSBC I 20662). Tampa Bay; J. Taylor, col., 1963; 4 specimens (USNM 54170). Same, 27°36'56"N, 82°41'05"W, 9 m, sand; J. Taylor and C. Saloman, cols., 25 Oct. 1963; 17 specimens (FSBC I 17926). Same, 27°36'38"N, 82°43'29"W, 11 m, sand; J. Taylor and C. Saloman, cols., 29 Oct. 1963; 1 specimen (FSBC I 17422).

*Description.*—Body without color markings; pharynx often surrounded

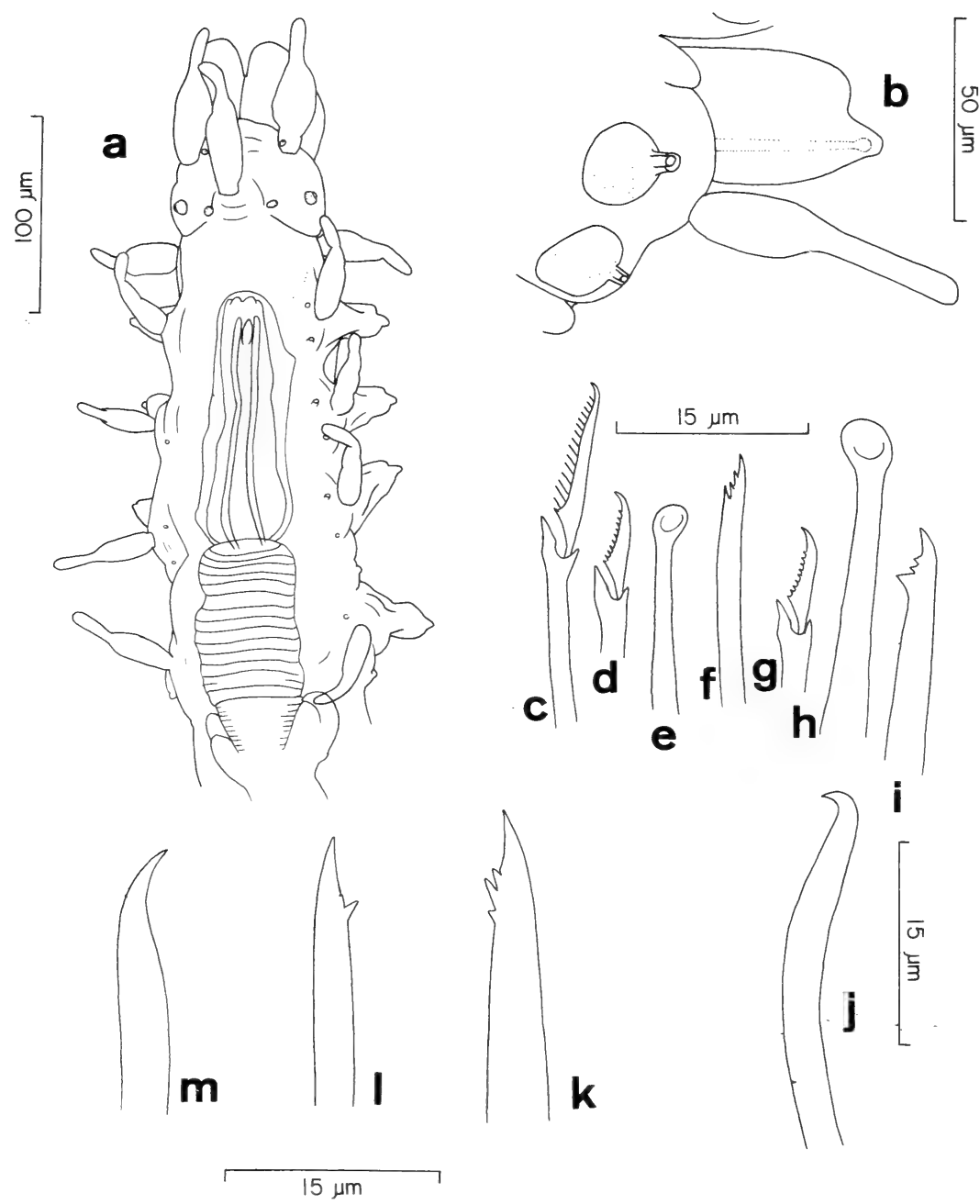


Fig. 9. *Parapionosyllis longicirrata*: a–j, Florida specimens: a, Anterior end of juvenile, dorsal view (FSBC I 20662); b, Anterior parapodium, dorsal view; c–f, Anterior setiger: c, Upper falciger; d, Lower falciger; e, Aciculum; f, Superior simple seta; g–j, Posterior setiger: g, Falciger; h, Aciculum; i, Superior simple seta; j, Inferior simple seta; k–m, Massachusettis specimen (USNM 27522): k, Superior simple seta, middle segment; l, Same, posterior segment; m, Inferior simple seta of same.

by brownish glands; paired, light brown glands often prominent above dorsal cirri and occasionally on palps. Some juveniles lacking eyes on prostomium; others with 3 pairs of eyes, single pair of anterior eyespots, 2 pairs of lensed eyes on posterior half; eyespots mostly absent and posterior 2 pairs greatly enlarged on sexually mature specimens. Subdermal glands, similar to parapodial glands, visible near anterior ends of palps of few specimens. Dorsal cirri on all setigerous segments. Dorsum not papillate, but each segment with 2 subdermal, dorsal glands on each side with openings above dorsal cirri (Fig. 9a, b). Superior simple setae (Fig. 9f, j) of anterior region of moderate size but greatly enlarged in posterior region. Compound setae 5–10 per parapodium (Figs. 9c, d, g); all finely serrate on blade edge; blades unidentate, dorsally long, shorter ventrally in anterior region, all about same length in posterior region; shafts with long tips smooth and pointed, collar surrounding socket of hinge, in face view, relatively long, thin, broader than remainder, easily broken. Inferior simple setae on posterior segments (Fig. 9j), about as stout as corresponding superior simple setae, strongly hooked near tips, smooth. Acicula (Fig. 9e, h) solitary, with widened, circular tips, relatively slender in anterior region, similar in shape but much stouter in posterior region. Some mature males and females with natatory setae beginning on setiger 11 or 12. Males with sperm from setiger 10 or 11 to near posterior end; females with 2 internal eggs or external embryos per segment beginning on setiger 11 or 12, extending to 5–10 segments from posterior end; embryos apparently in subspherical cases attached medially to ventral cirri.

Pharynx slightly longer than proventriculus, mostly found from anterior prostomial margin to posterior border of setiger 2; anterior margin smooth, surrounded by 10 soft lobes. Proventriculus found in 2–4 segments depending on contraction, mostly beginning at anterior border of setiger 3, cylindrical, about twice as long as wide, with about 15 transverse rows of muscle cells, anterior 6 small.

*Remarks.*—Florida specimens are in agreement with Massachusetts specimens identified by Pettibone (USNM 27522, 32519), except that superior simple setae, although similar, are more strongly serrate, and inferior simple setae are more strongly hooked (Fig. 9k–m). Setae of the paratype of *Pionosyllis manca* Treadwell appear identical with Florida specimens; however, antennae were missing from the specimen. Pettibone (1963) stated that *P. longicirrata* females had one egg per segment and embryos with up to 5 setigers attached ventrally to the body wall. Florida specimens have 2 eggs per segment, and external embryos, which occurred on 3 Florida specimens, were not highly developed. Florida, North Carolina and Massachusetts specimens have 2 subdermal glands above parapodia of each setigerous segment, but these could not be definitely confirmed on the paratype of *Pionosyllis manca* from Virginia. The figure of an upper simple seta illus-

trated from North Carolina specimens by Gardiner (1976:134, fig. 11p) is incorrect; it possibly was drawn from a damaged shaft of a compound seta.

*Pionosyllis* Malmgren, 1867  
*Pionosyllis gesae*, new species  
Fig. 10

*Material examined*.—FLORIDA: Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher *et al.*, cols., Mar. 1976; USNM 60456), 9 paratypes (USNM 60457–60459; ZMH P-16393; FSBC I 23545–23548). Sta. III, 27°22.0'N, 80°12.4'W, about 7 m, medium calcareous sand; 1 paratype (FSBC I 23551). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 4 paratypes (USNM 60460; ZMH P-13691; FSBC I 23549, 23550). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 1 paratype (FSBC I 23552).

*Description*.—Body without color markings. Slender; longest specimen 5.0 mm long (range, 2.9–5.0,  $n = 10$ ), posteriorly incomplete, with 50 setigerous segments; maximum number of setigerous segments 53 (34–53 for all 8 apparently complete specimens, 49–53 for 4 complete specimens). Prostomium (Fig. 10a, b) generally oval, slightly wider than long, composed of 3 indistinct lobes; anterior lobe between lateral antennae and in front of medial antenna; lateral lobes comprising lateral sides of prostomium beginning anteriorly inside lateral antennae, ending posteriorly near midline. Some specimens with 3 pairs of eyes; 2 large pairs in arc on posterior third of prostomium in line with origin of median antenna; small anterior pair medially adjacent to origins of lateral antennae; only anterior pair of eyespots visible on some specimens. Median antenna originating slightly posterior to mid-length of prostomium. Lateral antennae originating slightly posterolateral to anterior eyespots near anterior border of prostomium. Antennae long, slender, 3–4 times longer than prostomial width, considerably thicker than dorsal cirri. Palps flattened, anteriorly rounded, about as long as prostomial length, only slightly fused, if at all, at base. Band of cilia on each side of prostomium on anterior border of lateral lobes; ciliated nuchal organs on posterior part separated by posterior extension of prostomium. Tentacular segment occasionally similar in length to following segment, usually contracting to less than half that length; transverse band of cilia on dorsal side. Dorsal and ventral tentacular cirri similar to lateral antennae. Dorsal cirri absent from setiger 2; alternately long and very short on other segments; long dorsal cirri originating on short cirrophores, about  $1\frac{1}{2}$  times body width without parapodia; short cirri not as thick as long cirri, extending only about half distance to tips of parapodial lobes, apparently originating directly from body wall. Parapodial lobes (Fig. 10c, d) long, subcylindrical, truncate, well separated, with row of 4–5 tufts of cilia on dorsal and ventral sides; rows



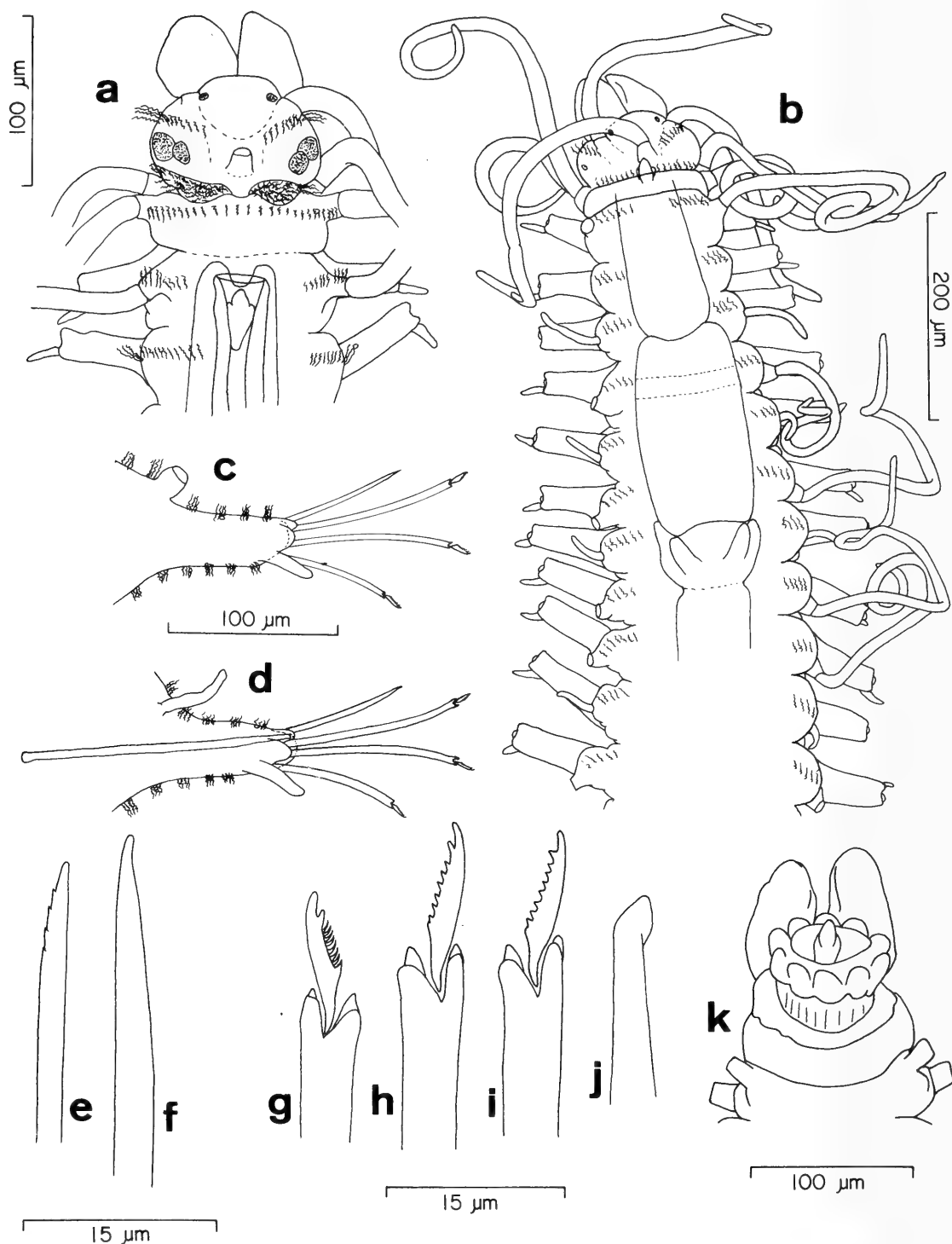


Fig. 10. *Pionosyllis gesae*: **a**, Anterior end, dorsal view (ZMH P-16393); **b**, Same (ZMH P-13691); **c**, Parapodium with long dorsal cirrus (missing), posterior view; **d**, Parapodium with short dorsal cirrus, posterior view; **e**, Superior simple seta, anterior setiger; **f**, Same, posterior setiger; **g-i**, Compound falcigers, middle setiger: **g**, Upper; **h**, Middle; **i**, Lower; **j**, Aciculum of same; **k**, Anterior end, showing proboscis, ventral view (FSBC I 23549).

of tufts apparently extending to dorsum in middle of each segment. Ventral cirri originating ventroposteriorly near tips of parapodia, subulate, extending slightly past parapodial tips. All parapodia with 3 compound falcigers and 1 superior simple seta; simple setae (Fig. 10e, f) straight, fine tipped, finely serrate near tips on anterior setigers, entirely smooth on middle and posterior setigers. Blades of falcigers with serrate margins, slightly falcate, bidentate with primary tooth larger. Blades of upper falcigers of anterior and middle segments (Fig. 10g) with about 8 long, fine teeth below secondary tooth, blade edges oriented ventrally. Two ventral falcigers (Fig. 10h, i) with blades having 6–7 or more short triangular teeth below secondary tooth, with blade edges oriented dorsally. Dentition of all falcigers in posterior parapodia similar to that of ventral 2 of anterior parapodia. Shaft tips of falcigers quadrilobate with pair of pointed lobes and pair of rounded lobes. Acicula solitary, parallel sided except for tips; tips slightly enlarged, bent anteriorly. Pygidium with pair of long anal cirri similar to longest dorsal cirri. Most sexually mature specimens with sexual products in about 20 segments beginning with setiger 9, products occasionally beginning in setiger 8 or 10, setiger 12 on one specimen. None with natatory setae.

Pharynx brownish, extending posteriorly to setiger 4 when inverted, with smooth anterior rim surrounded by 10 soft papillae (Fig. 10k). Median dorsal tooth anterior, trilobed; lateral lobes small; median lobe much longer and wider. Proventriculus slightly barrel-shaped, in setigers 5–7, with chitinous ring possibly in position indicated by dashed lines (Fig. 10b) but not obvious, with about 23 very irregular muscle cell rings.

*Remarks.*—*Pionosyllis gesae* is very similar to *Eusyllis heterocirrata* Hartmann-Schröder (1959:118–121, figs. 64–66), from El Salvador and eastern Africa. According to Dr. Hartmann-Schröder (personal communication), *E. heterocirrata* has all falcigers with similar, relatively coarse serrations, and ciliation is not visible. Further, she stated that she could not definitely determine that the pharynx of *E. heterocirrata* has a denticulate margin; if the pharyngeal margin of the latter species proves to be smooth, it should be referred to *Pionosyllis*. Additionally, *E. heterocirrata* has 26–30 segments and is 1.8–3.2 mm long including specimens from Tanzania and Natal, southeastern Africa. Thus, in addition to a possible difference in the pharynx and the presence of cilia, specimens of *P. gesae* are larger, have a greater number of segments and have blades of upper falcigers of anterior and middle segments with long, fine serrations. *Pionosyllis gesae* also shows some similarity to *Dioplosyllis* Gidholm, 1962, particularly in the shape of the prostomium and dorsal cirri and in having rows of cilia across the prostomium, peristomium and setigerous segments. However, the ventral arc of small teeth in the pharynx of *Dioplosyllis* is not present, and the chitinous ring in the proventriculus, if present, is indistinct.

*Etymology*.—The species is named in honor of Dr. Gesa Hartmann-Schröder, whose advice made possible description of this species and others.

*Pionosyllis uraga* Imajima, 1966

*Pionosyllis uraga* Imajima, 1966a:114, 116, fig. 37.—Banse and Hobson, 1968:16, 17, fig. 4f, g.

*Pionosyllis* cf. *uraga*.—Day, 1973:33, fig. 4k–m.

*Pionosyllis* sp.—Gardiner, 1976:137.

*Material examined*.—NORTH CAROLINA: off Beaufort, 34°19'N, 75°56'W, 130 m; J. H. Day, col., 1965; 1 specimen (USNM 51071). FLORIDA: Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 3 specimens (USNM 54521; FSBC I 20663). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 2 specimens (USNM 54519; FSBC I 20664). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 10 specimens (USNM 54520; FSBC I 20665–20671).

*Remarks*.—*Pionosyllis uraga* was described from Japan and has also been reported from Puget Sound, Washington (Banse and Hobson, 1968). North Carolina and Hutchinson Island specimens are in agreement with Imajima's description, except that the middorsal tooth is near the midpoint rather than near the anterior margin of the pharynx. Compound setae have fine serrations on blade edges and 3–4 rows of serrations on shaft tips. Acicula also appear to agree. All specimens from Florida and North Carolina are anterior pieces only, as was also the case with Imajima's specimens.

*Plakosyllis* Hartmann-Schröder, 1956

*Plakosyllis quadrioculata*, new species

Figs. 11, 12

*Material examined*.—FLORIDA: Hutchinson Island Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Sep. 1972; USNM 60219), 6 paratypes (USNM 54507; ZMH P-16394; FSBC I 23553, 23554). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 14 paratypes (USNM 54505, 54506, 60220; AHF Poly 1312, 1313; FSBC I 23555–23558). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 3 paratypes (FSBC I 23559, 23560).

*Description*.—Body without color markings. Maximum length 3.0 mm, width 0.3 mm; mature specimens with 30–55 setigers. Body strongly flattened, ribbon-like, gradually broadening for first 7–8 segments, parallel sided except for few segments near posterior end, cuticle thick on prostomium and body but not on cirri (Fig. 11b). Prostomium (Fig. 11a–c) about twice wider than long, trapezoidal, widest near anterior margin, with pair of ventrolateral lobes on anterior margin and much larger, broader middle lobe;

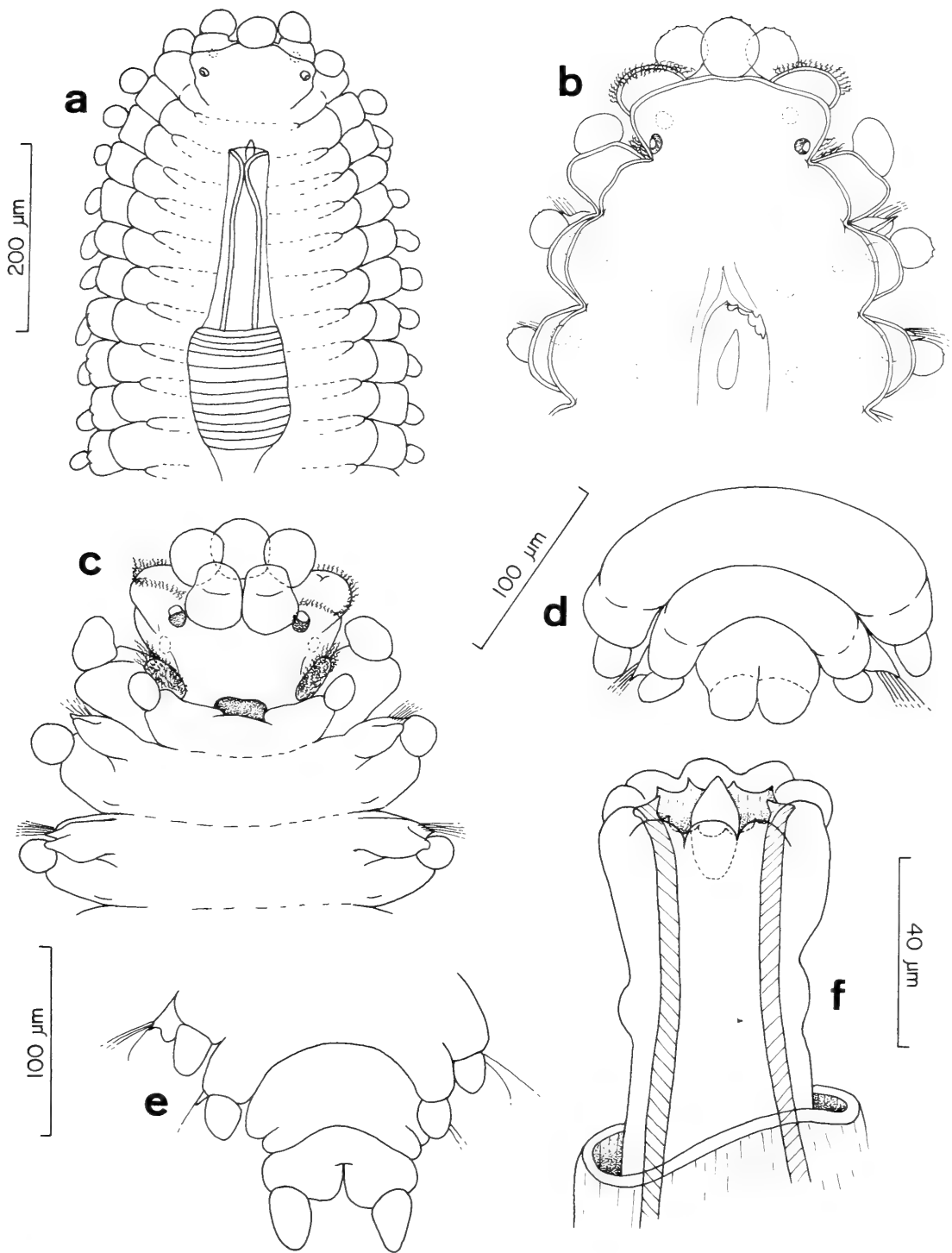


Fig. 11. *Plakosyllis quadrioculata*: a, Anterior end of holotype, dorsal view; b, Same, of small specimen (FSBC I 23555); c, Same, ventral view; d, Posterior end of holotype, dorsal view; e, Same (USNM 60220); f, Anterior end of everted pharynx, ventral view (USNM 60220).

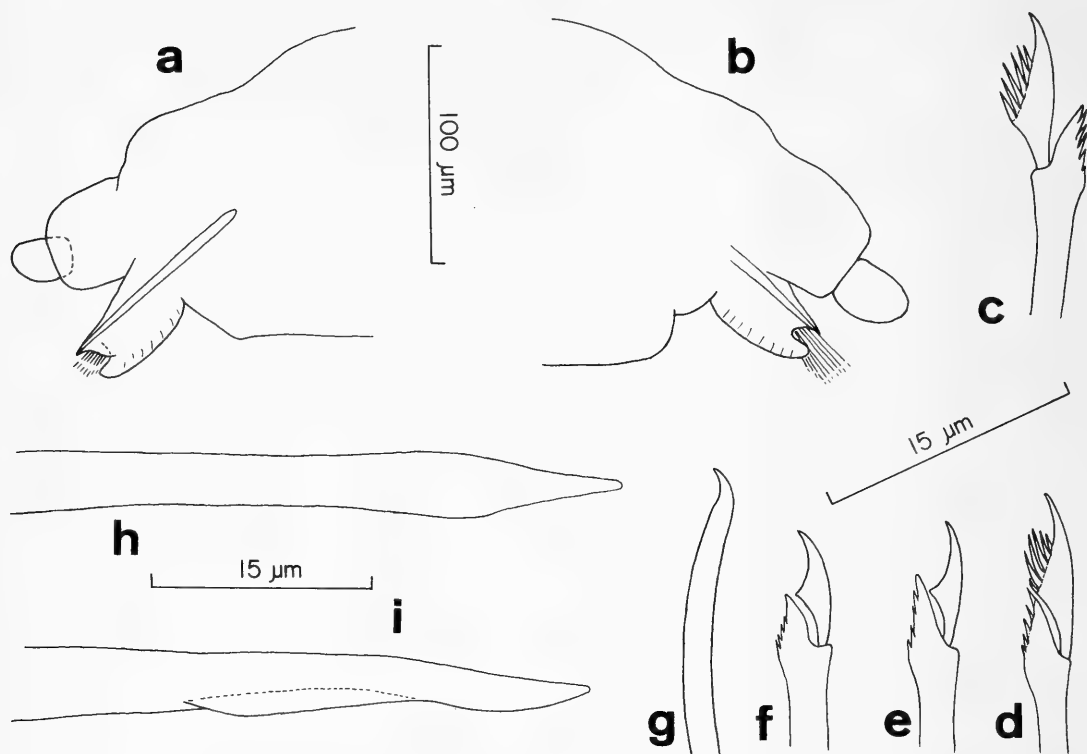


Fig. 12. *Plakosyllis quadrioculata* (a–g FSBC I 23554): a, Parapodium of midregion, anterior view; b, Same, posterior view; c, Upper compound seta, anterior setiger (blade turned); d, Same, posterior setiger; e, f, Lower compound setae, anterior setiger; g, Inferior simple seta; h, Aciculum, dorsal view (USNM 54506); i, Same, lateral view.

median antenna spherical, attached on anterior border of middle lobe; lateral antennae spherical, slightly smaller than median, attached on anterior borders of ventrolateral lobes; eyes lensed, 2 pairs, smaller pair dorsolateral near posterior border, larger pair ventral, lateral to bases of palps, closer together and more anterior than dorsal pair; palps originating near middle of ventral side, extending to near anterior border, oval in outline, apparently completely separated to bases; ciliary rows on ventrolateral lobes beginning in front of ventral eyes and extending to dorsal side of lobes above lateral antennae; ciliated nuchal organs ventrolateral, between prostomium and tentacular segment. Tentacular segment shorter than following segment, with 2 pairs of tentacular cirri; dorsal pair subequal to lateral antennae, slightly larger than dorsal cirri; ventral pair originating ventrally and not visible from dorsum, smaller than dorsal cirri. Setigerous segments (Fig. 12a, b) similar throughout, arched dorsally, straight or slightly concave ventrally, 8–10 times wider than long in mature specimens (Fig. 11a), relatively narrower in immature specimens (Fig. 11b). Dorsal cirri spherical to oblong, with single article, without visible sensory hairs but with small bumps indicating they were originally present, attached on much broader, stouter

cirrophores, tips extending laterally farther than setal lobes. Setal lobes acutely pointed. Ventral cirri fused with lower parts of setal lobes for most of their length, with unfused, conical tips extending almost to tips of setal lobes on posterior sides. Setae compound falcigers with short unidentate blades (Fig. 12d–f) on anterior and middle parapodia joined by slender, slightly hooked inferior simple setae on posterior setigers (Fig. 12g); compound setae 8–12, similar on all parapodia, of 2 types; 3–5 upper compound setae having blades 9–10  $\mu\text{m}$  long, proximally with about 6 long, slender serrations, with moderately hooked tips, shafts with 4–5 long spines on edge of distal end; 5–7 lower compound setae with smooth blades about 7  $\mu\text{m}$  long, shafts slightly stouter than shafts of upper setae, lightly serrate on distal end. Acicula (Fig. 12h, i) solitary, stout, slightly broadened near tips in dorsal view, ending in long, acute tips, often emergent or confined in pointed lobe on upper part of setal lobes. Dorsum of each segment of mature specimens with transverse row of subcuticular glands containing granular material; glands fewer and apparently empty in immature specimen (Fig. 11b). Pygidium (Fig. 11d, e) somewhat flattened, medially divided, with pair of lateroposterior anal cirri similar but larger than dorsal cirri of posterior segments; cirri well separated from remainder of pygidium by well defined constrictions; constrictions becoming obscure on fully developed sexual stolons. Sexual reproduction by posterior budding of stolons; stolons beginning on setigers 23–29, completely filled with sexual products except for 2–3 posterior segments, 2 with pair of large ventrolateral eyes on anterior stoloniferous segment; single female stolon with long natatory setae between dorsal cirri and setal lobes; female stolons with about 6 crowded, isohedral eggs per segment.

Pharynx (Fig. 11f) longer than proventriculus, slender, thick walled, located in setigers 1–5 or 6 of mature specimens when inverted, with trepan of 10 small, widely spaced, pointed teeth in addition to larger middorsal tooth, anterior border surrounded by 10 soft lobes. Proventriculus cylindrical to barrel-shaped, with about 14 rows of muscle cells with anterior 4–5 rows small, about 3 segments long, usually in setigers 7–9. Ratio of pharynx:proventriculus lengths about 3:2; both found in more anterior segments of immature specimens.

*Remarks.*—*Plakosyllis quadrioculata* differs from *P. brevipes* Hartmann-Schröder (1956:87–89, figs. 1–5) in having 2 pairs of eyes, one dorsal and one ventral, shorter ventral cirri, compound setae having upper blades with very long teeth throughout the body and shafts with very long, slender serrations on the distal end, inferior simple setae, and distinctly articulated anal cirri on specimens which are not sexually modified; also, *P. quadrioculata* lacks superior simple setae.

Type-specimens of *P. brevipes* were reported from Naples and Banyuls-sur-Mer in the Mediterranean Sea. Weinstein (1961) described a pair of small

ventral eyes on the prostomium of additional specimens of *P. brevipes* from Banyuls-sur-Mer in addition to the 2 dorsal pairs described by Hartmann-Schröder but did not report superior simple setae.

Gidholm (1962:250–252, fig. 1) reported 2 pairs of ventral eyes and a single dorsal pair on the prostomium of specimens referred to *P. brevipes* from Roscoff on the Atlantic coast of France. Setae of Gidholm's specimens also appear to differ from those described by Weinstein, and setae of posterior setigers described by Weinstein appear identical with setae originally described for the species by Hartmann-Schröder (1956:89, fig. 4). These differences suggest that Gidholm's specimens are referable to another species.

*Plakosyllis quadrioculata* differs from *P. americana* Hartman (1961:75, 76, pl. 33, fig. 1), which has a prostomium with 4 dorsal eyes and no ventral eyes, about 100 segments maximally and compound setae with entirely smooth shafts.

Hartmann-Schröder (1956) originally placed the genus in the subfamily Exogoninae because of reduction in antennae, palps, and cirri and because of the pronounced flattened condition of the body. Weinstein (1961) suggested that the genus was related to *Trypanosyllis* Claparède of the Syllinae and *Eurysyllis* Ehlers, 1864, which Fauvel (1923) placed in the Syllinae, but which Fauchald (1977) placed in the Exogoninae. Gidholm (1962) referred *Plakosyllis* to *Eurysyllis*. *Eurysyllis* species have large globular papillae on the dorsum; this and other differences and similarities were noted by Gidholm.

The only significant difference of *Plakosyllis* from the small *Trypanosyllis* species described herein is in the reduction of antennae, tentacular cirri, and dorsal cirri to a single article from the multiarticulate condition, and it is suggested that the genus be referred to the Syllinae along with the closely related *Eurysyllis*. In this regard, *Sphaerodoridium guilbaulti* Rullier (1974:33–35, fig. 2), based on a single specimen from the Atlantic coast of the United States, appears to be a *Eurysyllis*.

*Etymology*.—The specific name is derived from the Latin prefix *quadri*, meaning four, and *oculata*, having eyes, referring to the number of eyes.

### *Sphaerosyllis* Claparède, 1863

*Remarks*.—Previous reports of this genus from eastern North America, the Bahamas, and Cuba have been included under 10 specific names. *S. brevifrons* Webster and Benedict, 1884, and *S. longicauda* Webster and Benedict, 1887, have been referred to *S. erinaceus* Claparède, 1863 (Pettibone, 1963), although it appears that both are distinct from one another and from *S. erinaceus*. *S. hystrix* Claparède was recorded by Pettibone (1963) from South Norwalk, Connecticut; the specimens, first reported by Webster and Benedict (1884) as *S. brevifrons*, are referred herein to *S. taylori*, n.

sp. *S. renaudae* Hartmann-Schröder, 1958, was described from a single anterior fragment from Bimini, The Bahamas. A solitary specimen reported as *S. pirifera* [not Claparède, 1868] from North Carolina by Day (1973) and Gardiner (1976) is referred herein to *S. glandulata*, n. sp. Specimens from North Carolina reported as *S. erinaceus* by Gardiner (1976) are referred to *S. longicauda*. *S. centroamericana* Hartmann-Schröder, 1959, was recently reported from Cuba by Hartmann-Schröder (1979). An additional new species, *S. labyrinthophila*, recently described by Gardiner and Wilson (1979) from North Carolina, was also collected at Hutchinson Island.

*Sphaerosyllis erinaceus* and *S. hystrix* were also reported from Delaware by Kinner and Maurer (1978), and *S. hystrix* by Maurer *et al.* (1976); I have not examined their specimens and confirmed their records. However, *S. hystrix* and *S. erinaceus* are European species, and I have no evidence that they occur in the northwestern Atlantic from numerous specimens of this genus that I have examined. *S. hystrix* specimens reported by Kinner and Maurer (1978) and Maurer *et al.* (1976) are probably *S. taylori*, n. sp. Specimens of *S. erinaceus* (a doubtful species in my opinion) reported by Kinner and Maurer (1978) are probably *S. longicauda*. *S. hystrix* and *S. erinaceus* are therefore not included in the key.

*Sphaerosyllis longicirrata* Webster and Benedict was discussed above as a member of the genus *Parapionosyllis* Fauvel, 1923. Another species, *S. fortuita* Webster, 1879, was described from a single Virginia specimen. The specimen was apparently never deposited in the U.S. National Museum of Natural History where most of Webster's types are found. I cannot definitely decide from the original description that the species is a member of *Sphaerosyllis* Claparède.

As far as I can determine, species names noted above include only 7 *Sphaerosyllis* species, 2 of which are newly described. An additional 8 new species are described herein, increasing the number of known species in the genus from eastern North America to 13.

Characters of systematic importance at the species level include: number and position of prostomial eyes; degree and character of fusion between the prostomium and tentacular segment; presence or absence of nuchal organs; relative sizes and shapes of antennae, tentacular cirri, dorsal cirri, and anal cirri; presence or absence of dorsal cirri on the second setigerous segment; fine detail of the setae; changes in setae within parapodia and along the body; shape of acicula and changes in acicular size along the body; arrangement, number, and possibly length of glandular papillae; presence or absence of segmental glands opening above dorsal cirri and the contents thereof; specific segments in which sexual products and natatory setae occur; number of embryos per segment and position of incubated embryos, either dorsal or ventral; segmental positions and length-width ratios of the pharynx and proventriculus; size and position within the pharynx of the pharyngeal



tooth; arrangement and number of rows of muscle cells of the proventriculus; and possibly the length and width of the body and the number of segments. Additionally, I have described what appear to be dorsal and lateral lobes of the brain extending into the first and second setigers. The structures were discovered in cleared, unstained specimens, and their existence was tentatively confirmed by histological examination. The structures are contiguous with the dorsal parts of the brain in the prostomial lobe, and histological examination indicates them to be surrounded by a membrane continuous with that surrounding the brain. The specimens, however, were poorly preserved for critical histological examination. The structures may be of systematic importance as indicated in the species descriptions.

### Key to *Sphaerosyllis* Species from Eastern North America

1. Eyes absent ..... *S. renaudae*
- Eyes present ..... 2
2. Four eyes ..... 3
- Six eyes ..... 8
3. Eyes on anterior and posterior prostomial margins; acicula slender, straight, pointed ..... *S. brevidentata*, n. sp.
- Eyes on posterior half of prostomium; acicula stout, with tips bent forward at about right angles ..... 4
4. Dorsal parapodial glands absent ..... *S. piriferopsis*, n. sp.
- Dorsal parapodial glands beginning on setiger 4 or 5 ..... 5
5. Parapodial glands filled with rods ..... 6
- Parapodial glands filled with spheres or granules ..... 7
6. Superior simple setae and compound setae in middle segments ...  
..... *S. taylori*, n. sp.
- Superior simple setae and simple acicular setae in middle segments  
..... *S. aciculata*, n. sp.
7. Median antenna originating near posterior prostomial margin; blades of upper compound setae of anterior segments about 12  $\mu$ m long ..... *S. glandulata*, n. sp.
- All antennae originating on anterior prostomial margin; blades of upper compound setae of anterior segments about 40  $\mu$ m long  
..... *S. magnidentata*, n. sp.
8. Two pairs of eyes on prostomium in flattened, trapezoidal arrangement open posteriorly and third pair near posterior border of tentacular segment; anterior pair large ..... *S. centroamericana*
- All eyes on prostomium; anterior pair small ..... 9
9. Blades of compound setae bidentate ..... *S. bilobata*, n. sp.
- Blades of compound setae unidentate ..... 10

- 10. Pygidium with midventral anal cirrus; integumental papillae both long and short ..... *S. longicauda*
  - Midventral anal cirrus absent; all integumental papillae similar in size (short) ..... 11
- 11. Paired, semicircular nuchal folds covering posterior eyes; blades of upper compound setae of anterior segments about 30  $\mu$ m long ..... *S. labyrinthophila*
  - Paired nuchal folds absent; blades of compound setae of anterior segments about 10  $\mu$ m long ..... 12
- 12. Prostomium and tentacular segments fused; anal cirri slender; length to 1.5 mm, with 17 setigers ..... *S. riseri*, n. sp.
  - Prostomium and tentacular segments distinct; anal cirri bulbous; greater than 2.5 mm long, with 27 setigers ..... *S. brevifrons*

*Sphaerosyllis aciculata*, new species

Figs. 13, 14

*Material examined*.—FLORIDA: Hutchinson Island Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Nov. 1971; USNM 60221), 1 paratype (USNM 60222). Sta. I, 27°21.3'N, 80°14.1'W, about 8 m, very fine to fine quartose sand; 1 paratype (FSBC I 23561). Tampa Bay, 27°36'20"N, 82°40'49"W, 8 m, sand; J. Taylor and C. Saloman, cols., 25 Oct. 1963; 1 paratype (FSBC I 23562). Tarpon Springs, Anclote Anchorage, 1 mi W of Bailey's Bluff, 4–5 m, shelly sand; R. Ernest, col., Nov. 1973; 1 paratype (FSBC I 23563). Same, 28°11.8'N, 82°47.6'W, 2.5 m, sand with *Syringodium* cover; J. Studt and R. Ernest, cols., 5 Dec. 1975; 1 paratype (ZMH P-16395).

*Description*.—Parapodial glands brown to light yellowish brown. Maximum length 2.2 mm; width about 0.1 mm excluding parapodia; maximum of 21 setigerous segments. Prostomium clearly fused with tentacular segment (Fig. 13a, b), with latter surrounding posterior and lateral sides of prostomium as fold covering posterior part of prostomial lobe. Median antenna originating on anterior edge of fold, possibly shorter than lateral antennae. Lateral antennae originating on anterolateral margins of prostomium on short, anterior projections (distinct in contracted specimen). Anterior margin of prostomium slightly concave. Two pairs of lensed eyes on posterior half, in flattened, rectangular arrangement; anterior pair slightly larger. Palps long when not turned under or contracted; anterior fourth not fused; anterior notch and dorsal median furrow evident in relaxed specimen. Tentacular cirri originating dorsally on lateral projections of tentacular segment on about same line as origins of lateral antennae (Fig. 13a); cirri directed upward on short projections on relaxed specimen (Fig. 13b), directed anteromedially around front of prostomium on contracted specimen. Glan-

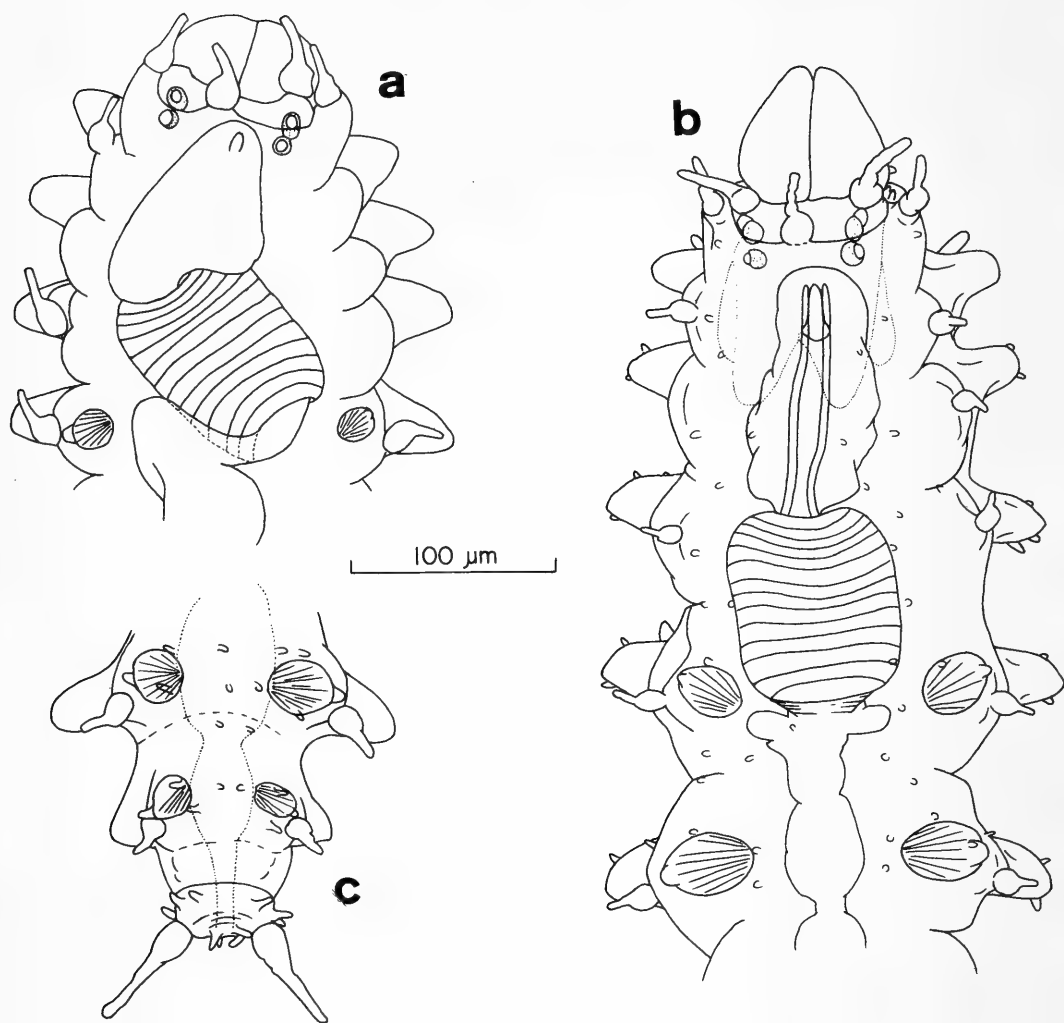


Fig. 13. *Sphaerosyllis aciculata*: a, Anterior end of contracted specimen, dorsal view (USNM 60222); b, Same, holotype; c, Posterior end, dorsal view.

dular papillae on tentacular segment below and above tentacular cirri. Dorsal lobes of brain (Fig. 13b) extending posteriorly to middle of setiger 2; lateral lobes extending to near posterior edge of setiger 1. Dorsum of each segment with 8–10 small glandular papillae. Single specimen with dorsal cirrus on one parapodium of setiger 2; dorsal cirri absent on setiger 2 of remaining specimens; cirri relatively small, not extending past tips of parapodial lobes of other segments, spherical bases and cylindrical tips of about equal length. Parapodial lobes blunt with single anterior and single posterior apical papillae; third papilla sometimes evident on anterior edge about half distance from base to tip. Ventral cirri short, cylindrical. Solitary, superior simple setae (Fig. 14a–c) on all parapodia, relatively broad in lateral view. Setigers 1–8 with 4 short-bladed compound setae (Fig. 14d, e); blades of

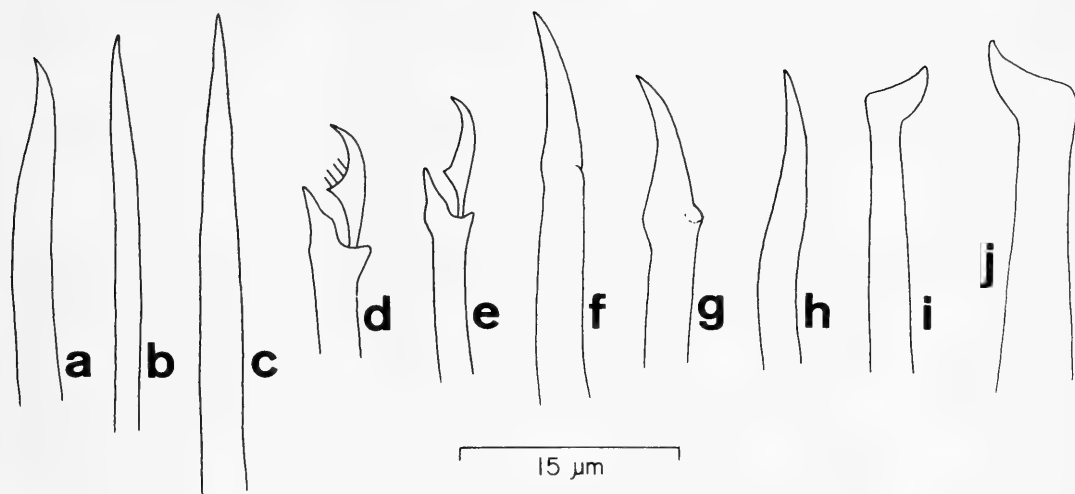


Fig. 14. *Sphaerosyllis aciculata*: a, Superior simple seta, setiger 6, lateral view; b, Same, dorsal view; c, Same, posterior setiger; d, Upper falciger, setiger 6; e, Lower falciger of same; f, Upper simple acicular seta, posterior setiger; g, Lower simple acicular seta of same; h, Inferior simple seta of same; i, Aciculum, setiger 6; j, Same, posterior setiger.

uppermost seta finely serrate. Following segments with compound setae replaced with about 3 slightly enlarged, simple, acicular setae (Fig. 14f, g) homologous with shafts of anterior compound setae; upper acicular setae more highly modified, showing little resemblance to shafts; tips of lowermost acicular setae strongly similar to tips of shafts of anterior compound setae. Solitary, inferior simple setae (Fig. 14h) on posterior parapodia. Acicula (Fig. 14i, j) solitary, stout in anterior region, about twice as stout in posterior region, with tips slightly enlarged and bent forward at almost right angle. Parapodial glands (Fig. 13b) containing rods, beginning with setiger 4, extending to posterior end; glands opening on dorsum above dorsal cirri; one gland empty, another partly empty on one specimen. Pygidium (Fig. 13c) with pair of long, stout, anal cirri, generally similar to dorsal cirri; in addition, pygidium with 10 long papillae visible in dorsal view. One female with internal eggs in setigers 7–15.

Pharynx very narrow, with moderately thick walls, surrounded by relatively large but not prominently colored glandular region. Relatively large middorsal tooth anterior, about as wide as anterior opening. Pharynx located in setigers 1 and 2 of relaxed specimen. Proventriculus shorter than pharynx, only slightly longer than wide, extending through about  $1\frac{1}{2}$  segments in setigers 3 and 4. Muscle cells arranged in 13–14 irregular transverse rows, anterior 4–5 small. Relative lengths of pharynx to proventriculus 5:4.

*Remarks.*—*Sphaerosyllis aciculata* differs from other species in the genus in having compound setae replaced entirely by simple, acicular setae in middle and posterior segments.

*Etymology*.—The specific name is derived from Latin and refers to the aciculated setae.

*Sphaerosyllis bilobata*, new species

Figs. 15, 16

*Material examined*.—FLORIDA: Hutchinson Island Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Nov. 1971; USNM 60465), 5 paratypes (USNM 60466, 60470; FSBC I 23565–23567). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 4 paratypes (FSBC I 23568–23571). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 10 paratypes (USNM 60467–60469; FSBC I 23572–23575).

*Description*.—Body without color markings; eyes reddish. Maximum length 1.9 mm, about 0.1 mm wide without parapodia, 26 setigers. Prostomium (Figs. 15a, 16a) wider than long, anteriorly convex, almost semicircular; posterior border nearly straight; sides rounded. Lateral antennae originating on anterolateral borders of prostomium lateral to anterior eyespots; about half length of median. Median antenna originating from posterior border of prostomium on short lobe separate from tentacular segment and associated lobes; length about equal to median prostomia length. Three pairs of eyes; pair of eyespots on anterior margin at about middle of each side; 2 pairs of lensed eyes on posterior half, with anterolateral pair much larger on sexually mature specimens (Figs. 15a, 16a). Dorsal lobes of brain extending to posterior border of setiger 1; lateral lobes extending well into setiger 2. Palps anteriorly rounded, much shorter than prostomium, appearing completely fused dorsally except for median furrow. Tentacular segment distinct dorsally, about half as long as following segment, intermediate in width between narrower prostomium and wider setiger 1; tentacular cirri originating lateral to posterior pair of lensed eyes, about half size of lateral antennae and dorsal cirri; pair of eyelid-like nuchal folds on anterior margin of tentacular segment covering ciliated nuchal organs between prostomium and tentacular segment and posterior 2 pairs of eyes (Figs. 15a, 16a), beginning medially near midline, extending around lateral margins of prostomium, ending above tentacular cirri; no glandular papillae. Dorsal cirri absent from setiger 2, replaced by glandular papillae. Dorsum of each segment otherwise with about 4 short papillae. Dorsal cirri of remaining segments with spherical bases and cylindrical tips, shorter than setigerous lobes; spherical parts about equal in length to cylindrical parts. Setigerous lobes (Fig. 15d) conical, acutely pointed; 2 small papillae usually visible, one on anterior side about half distance from base to tip, other on posterior side near tip. Ventral cirri cylindrical, less than half length of setigerous lobes. Solitary, superior simple setae (Fig. 15j) on all parapodia,

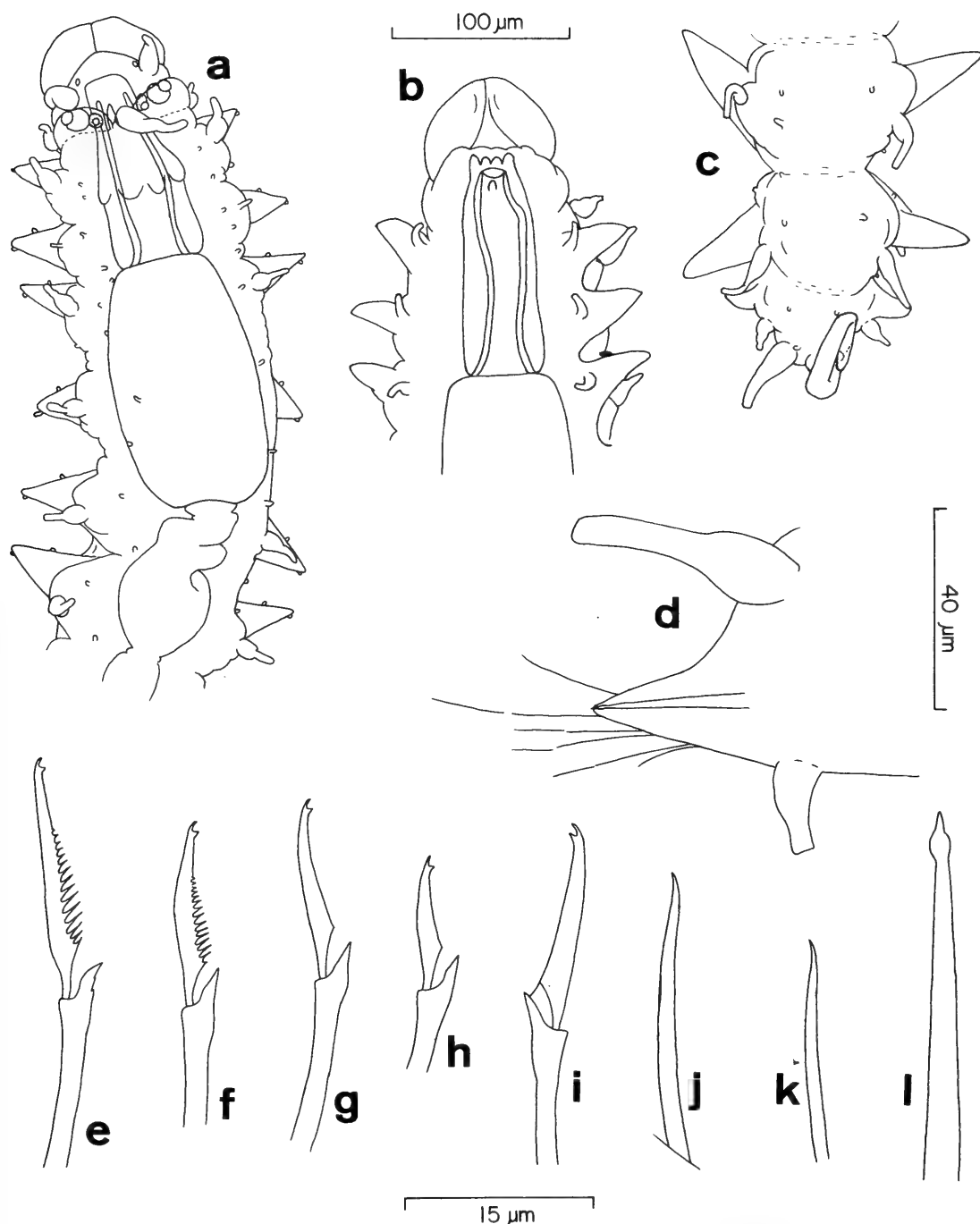


Fig. 15. *Sphaerosyllis bilobata*: a, Anterior end, dorsal view (USNM 60469); b, Same, ventral view (USNM 60467); c, Posterior end, dorsal view (USNM 60469); d, Posterior parapodium, posterior view; e-h, Compound setae, anterior setiger: e, Upper; f, Upper middle; g, Lower middle; h, Lower; i-k, Posterior setiger: i, Middle compound seta; j, Superior simple seta; k, Inferior simple seta; l, Aciculum, anterior setiger.

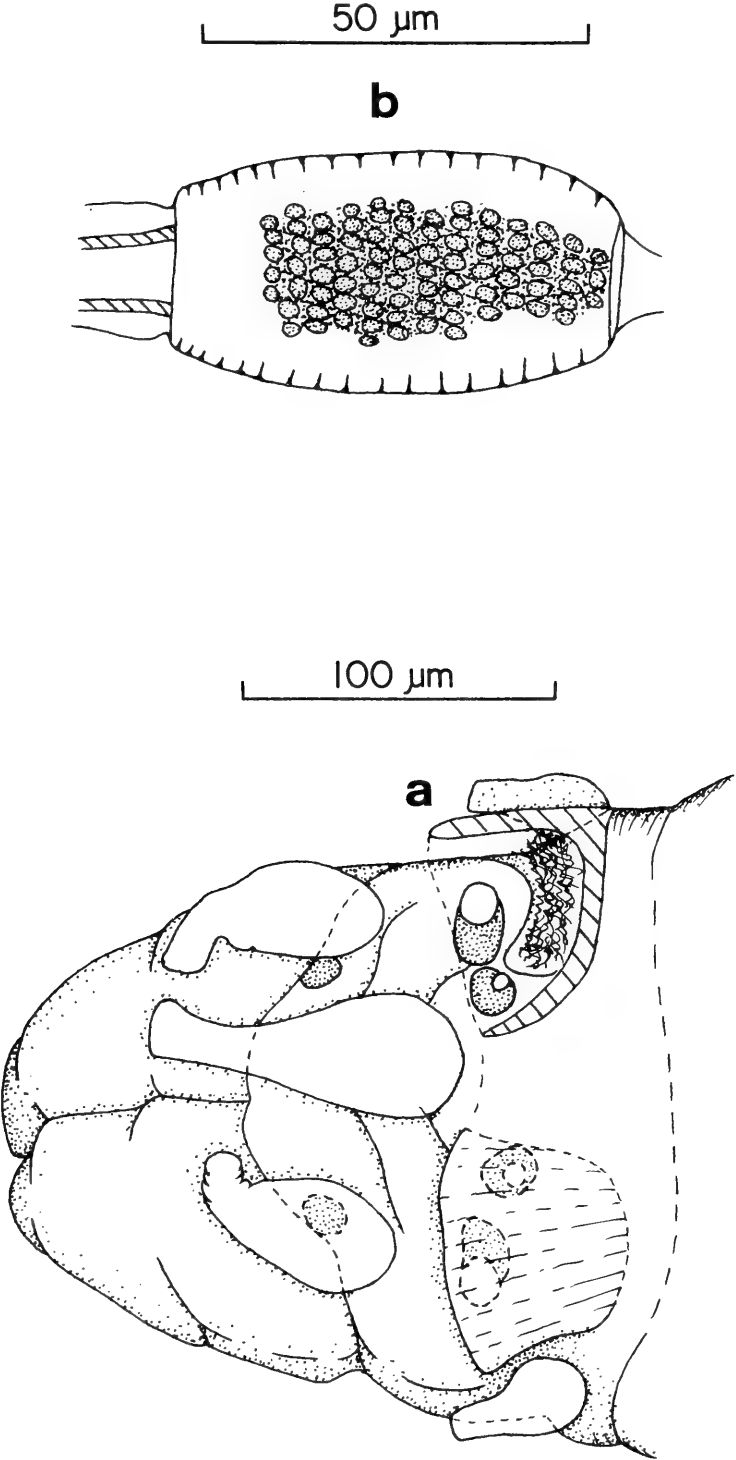


Fig. 16. *Sphaerosyllis bilobata*, paratype (USNM 60466): **a**, Anterior end, slightly turned dorsal view, showing cutaway of eyelid-like fold on right side beginning laterally with extreme lateral margin of fold; **b**, Proventriculus, dorsal view, showing arrangement of muscle cells.

slender, smooth, about as long as shafts of compound setae. About 5 compound setae (Fig. 15e–h) on anterior parapodia, 4 on posterior parapodia, similar; blades bidentate with similar primary and secondary teeth; upper blades about 20  $\mu\text{m}$  long, with fine serrations on basal  $\frac{2}{3}$ ; lower blades smooth, about 10  $\mu\text{m}$  long. Inferior simple setae on posterior parapodia (Fig. 15k), more slender, shorter than superior simple setae. Acicula (Fig. 15 l) solitary, slender; each with subdistal bulb and conical tip. Pygidium short, subcylindrical, with few glandular papillae; anal cirri stouter than dorsal cirri, 3–4 times longer. Embryos 2 per segment, found dorsally on setigers 9–19 of some sexually mature females; females mostly with internal eggs. Sperm in setigers 9 to 21–24 in males. Natatory setae on one specimen beginning with setiger 9.

Pharynx surrounded by thick, brownish glands or lobes, usually extending to posterior margin of setiger 2, with anterior end narrower than remainder; chitinous wall relatively thick, narrow, slightly shorter than length of proventriculus; middorsal tooth anterior, of average size; anterior end surrounded by soft lobes. Proventriculus barrel-shaped, in setigers 3–5; 18–19 transverse rows of muscle cells, anterior 5 small; cells in dorsal view also arranged in 2 opposite diagonal planes (Fig. 16b).

*Remarks.*—*Sphaerosyllis bilobata* is very similar to *S. erinaceus bidentata* Hartmann-Schröder (1974b:134, figs. 116–119) from West Africa [= *S. bidentata*]. It differs in the following characters: shape of tentacular folds covering posterior part of the prostomium; relative sizes of median and lateral antennae and tentacular and dorsal cirri; relative lengths of upper and lower compound setae; and lack of dentition on lower compound setae and superior simple setae of *S. bilobata*.

*Etymology.*—The specific name is derived from the Latin prefix, *bi-*, meaning double or twice, and the latinized Greek adjective, *lobata*, meaning lobed, and refers to the tentacular lobes.

*Sphaerosyllis brevidentata*, new species

Fig. 17

*Material examined.*—FLORIDA: Hutchinson Island Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Jan. 1973; USNM 60215), 1 paratype (FSBC I 23564). THE BAHAMAS: S portion of Bimini Lagoon, 25°43'N, 79°16'W, in submerged plastic sponges; A. Schoener, col., 1970–1971; 1 paratype (USNM 51547).

*Description.*—Body without color markings; pharynx surrounded by brownish glands. Length 1.2 mm; width 0.13 mm without parapodia, 0.18 mm with parapodia; male with 17 setigers; female with 14 setigers. Prostomium (Fig. 17a) oval, about twice as wide as long. Two pairs of lensed eyes; anterior pair in position usually occupied by minute eyespots on *Sphaero-*



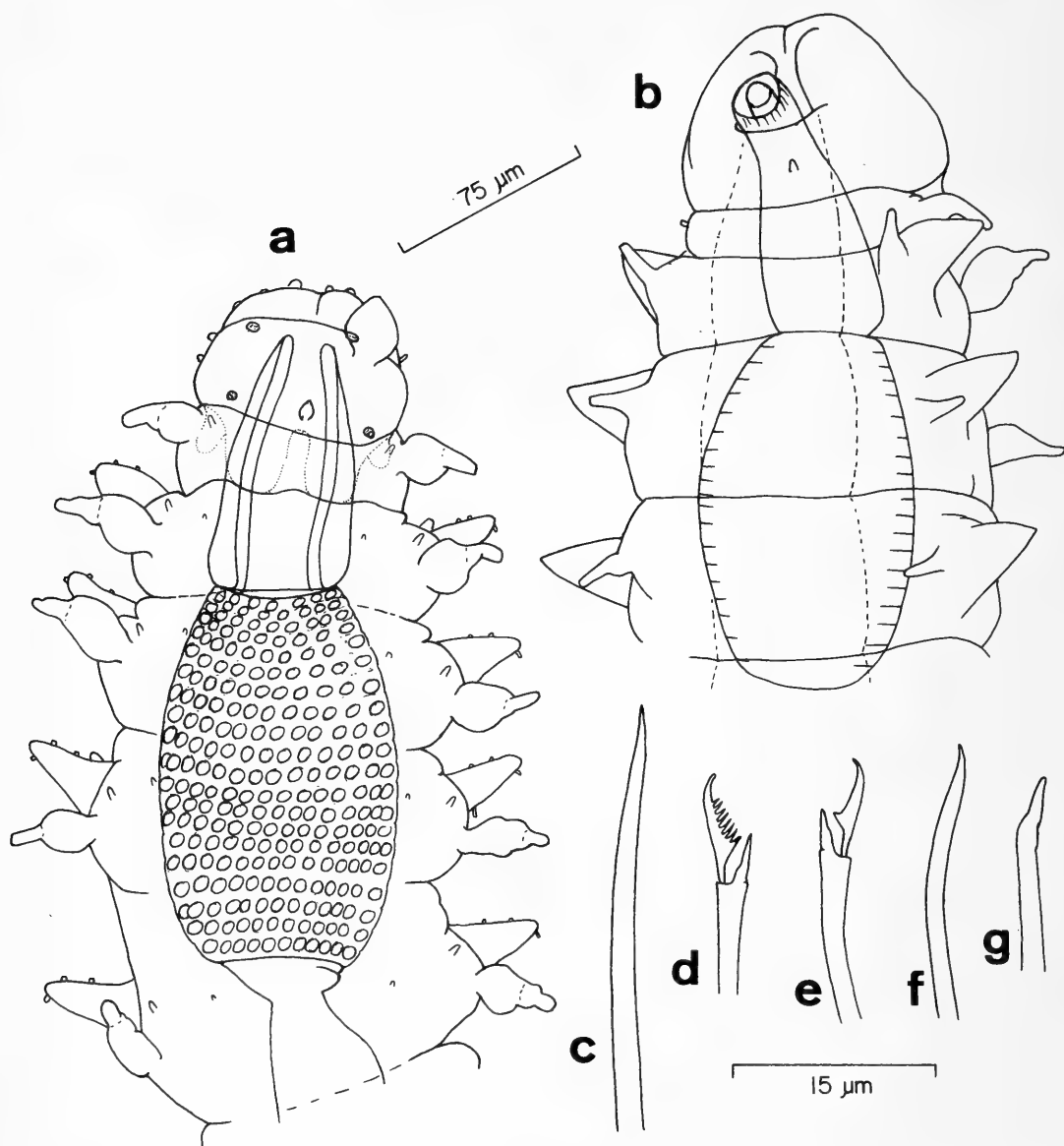


Fig. 17. *Sphaerosyllis brevidentata*: a, Anterior end, dorsal view (FSBC I 23564); b, Same, holotype, ventral view; c, Superior simple seta, posterior setiger; d, Upper compound seta; e, Lower compound seta; f, Inferior simple seta; g, Aciculum.

*syllis* spp. having 3 pairs of eyes, on anterior margin slightly medial to lateral antennae; posterior pair small, located near posterolateral margin. Median antenna missing; single lateral antenna on anterior margin, extending anteriorly about to tips of palps, pyriform, without usual cylindrical tip. Lobes of brain very short; dorsal lobes extending to beginning of setiger 1, covered by very thin integument; lateral lobes extending about half that distance. Palps very short, papillate, completely fused except for median furrow. Tentacular segment dorsally distinct, completely separated from prostomium, unmodified, about  $\frac{2}{3}$  length of following segment in relaxed specimen

but reduced by about half in another specimen, without tentacular folds covering part of prostomium, with glandular papillae above tentacular cirri. Dorsum with 4 papillae per segment; larger pair situated slightly in front of dorsal cirri; smaller pair medial to larger pair. Dorsal cirri on all setigerous segments, similar in size and shape to tentacular cirri, extending laterally for about same distance as parapodial lobes, with globular bases indistinctly separated from tips, often with 2 constrictions of cylindrical parts. Parapodial lobes conical, with slightly rounded tips, with at least 1 papilla on anterior margin short distance from tips, and another on posterior side near tips. Ventral cirri short, cylindrical, attached to bases of parapodial lobes. Solitary, superior simple setae (Fig. 17c) on all parapodia and solitary, inferior simple setae (Fig. 17f) on posterior segments; both smooth, tips acute; inferior simple setae strongly curved, not as stout as superior simple setae. Four compound setae (Fig. 17d, e) with short blades on all parapodia; blades slightly curved, unidentate, upper 2 serrate, lower 2 smooth. Solitary aciculum (Fig. 17g) in each parapodium, slightly curved near tip; tip long, conical. Pygidium hemispherical, with long, glandular papillae; anal cirri lost. Mature male with sexual products in setigers 7–12; scars of external embryos visible on female, 2 per segment, on dorsum of setigers 7–10.

Pharynx (Fig. 17a, b) thickly chitinized, beginning near level of anterior pair of eyes, extending to posterior part of setiger 1, about 0.11 mm long, with small anterior opening; middorsal tooth small, located  $\frac{1}{4}$  to  $\frac{1}{3}$  of distance from anterior end. Proventriculus barrel-shaped, in setigers 2, 3, and part of 4; length about 0.13 mm; width about 0.05 mm. Muscle cells in dorsal view arranged in 3 planes: prominent, transverse plane and 2 opposite diagonal planes, with 19–20 transverse rows, anterior 5 small.

*Remarks.*—*Sphaerosyllis brevidentata* shows some resemblance to *S. brevifrons* Webster and Benedict (1884:714, 715, pl. 3, figs. 24–30) and *S. riseri*, n. sp., but differs from both in having only 2 pairs of eyes, one pair of which is located on the anterior prostomial margin and the other located on the posterior prostomial margin. Type-specimens and others of *S. brevifrons* have a similar tentacular segment, antennae, and cirri to those of *S. brevidentata*, but *S. brevifrons* is a much larger species. Antennae and cirri of *S. riseri*, n. sp., have distinct spherical bases and cylindrical tips, with the tips contracted into the bases; *S. riseri* also has a prostomium and tentacular segment showing a great deal of fusion.

*Etymology.*—The specific name is derived from Latin, and refers to the small pharyngeal tooth of this species.

*Sphaerosyllis glandulata*, new species

Figs. 18, 19

*Sphaerosyllis* sp. Taylor, 1971:229–231, fig. 5g–j.—Hall and Saloman, 1975:12 [list].

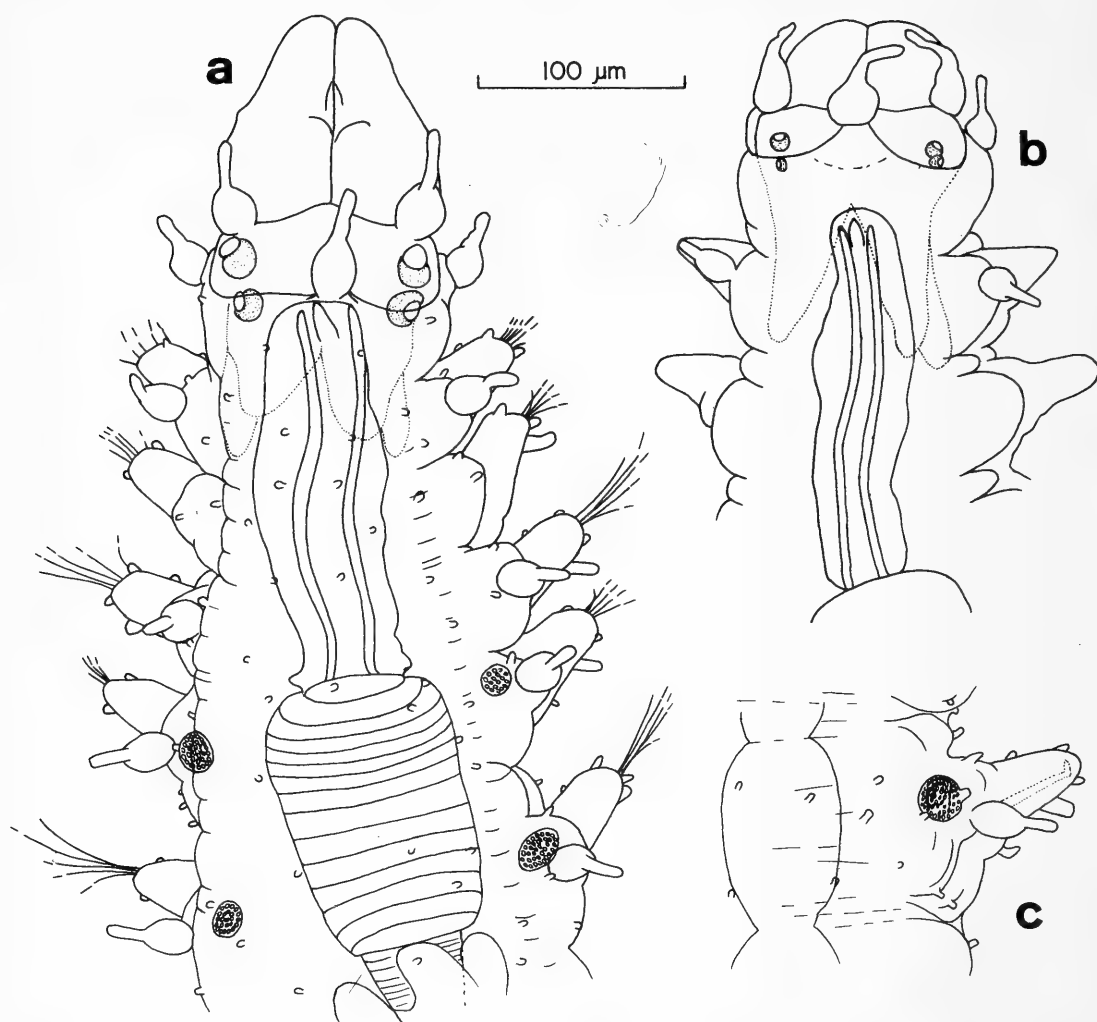


Fig. 18. *Sphaerosyllis glandulata*: a, Anterior end, dorsal view (USNM 60217); b, Same, contracted specimen (AHF Poly 1315); c, Middle segment, dorsal view (not scaled).

*Sphaerosyllis pirifera*.—Day, 1973:34.—Gardiner, 1976:131, fig. 10p–r [not Claparède, 1868].

*Material examined*.—FLORIDA: Hutchinson Island Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Nov. 1972; USNM 60216), 14 paratypes (USNM 60218; ZMH P-16396; FSBC I 23578–23585). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 9 paratypes (USNM 60217; AHF Poly 1314; ZMH P-16397; FSBC I 23586–23590). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 17 paratypes (AHF Poly 1315; FSBC I 23591–23598). Tampa Bay, 27°36'15"N, 82°43'22"W, 9 m, sand; J. Taylor and C. Saloman, cols., 25 Oct. 1963; 3 paratypes (FSBC I 23599). Same; J. Taylor, col., 1963; 7

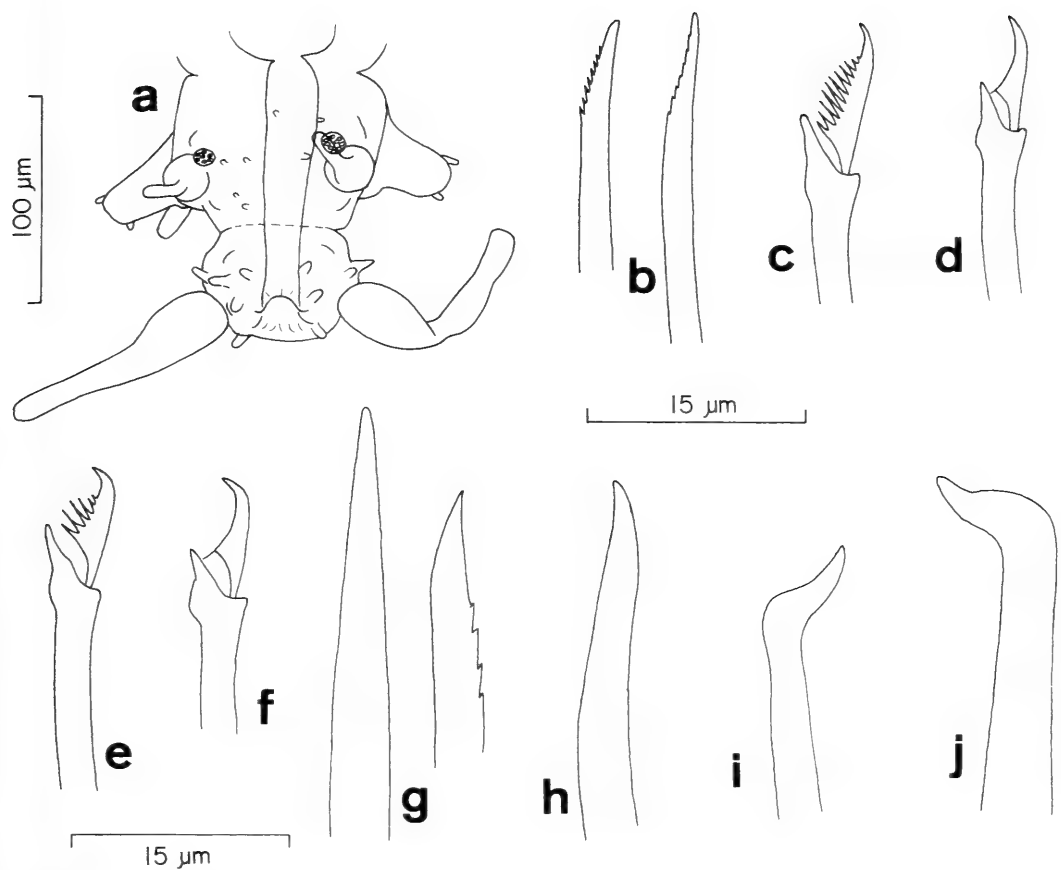


Fig. 19. *Sphaerosyllis glandulata*: a, Posterior end, dorsal view (USNM 60217); b, Superior simple setae, anterior setiger; c, Upper falciger, anterior setiger; d, Lower falciger of same; e, Upper falciger, posterior setiger; f, Lower falciger of same; g, Superior simple setae, posterior setiger, dorsal and lateral views; h, Inferior simple seta, posterior setiger; i, Aciculum, anterior setiger; j, Same, posterior setiger.

paratypes (USNM 45555). NORTH CAROLINA: off Beaufort, 20 m, sand and broken shell; J. H. Day, col., 1965; 1 paratype (USNM 51074).

*Description.*—Body without color markings; pharynx surrounded by light, brownish glands; parapodial glands yellow, obscure. Maximum length 7.0 mm, width 0.18 mm without parapodia, 45 setigers. Prostomium and tentacular segment fused (Fig. 18a, b); tentacular segment forming fold covering posterior part of prostomium; median antenna originating from fold. Two pairs of lensed eyes on posterior half, in flattened trapezoid arrangement, anterior and wider pair usually slightly larger. Lateral antennae originating on anterolateral margins of prostomial lobe in front of anterior pair of eyes, with bulbous bases and cylindrical tips, similar to median antenna; antennae about 1½ times lengths and widths of tentacular and dorsal cirri. Glandular papillae absent from prostomium. Dorsal lobes of brain extending into setiger 1; lateral lobes slightly longer. Palps together about as wide as

prostomium, extended or bent ventrally, about as long as antennae when turned ventrally. Tentacular segment enclosing most of lateral margins of prostomial lobe, with arc of few glandular papillae on dorsum. Tentacular cirri smaller than antennae, originating on transverse line below anterior pair of eyes. Several short, glandular papillae on dorsum and parapodial lobes of each setiger in median segments (Fig. 18c). Dorsal cirri absent from setiger 2; replaced by glandular papillae. Dorsal cirri of other segments similar to antennae but smaller, not extending past tips of setigerous lobes, with bulbous bases oval in outline, mostly longer than cylindrical tips. Setigerous lobes stout, bluntly rounded. Ventral cirri slender, cylindrical, not extending past tips of setigerous lobes. Solitary, superior simple setae (Fig. 19b, g) present from setiger 1 on all but largest specimens, beginning behind first several setigers on latter, with slightly bent, slightly serrate tips on anterior setigers, much stouter on posterior segments, with 4 stout teeth on lower sides near tips. Four compound setae on anterior parapodia (Fig. 19c, d); blades of upper slightly longer than lower (12–8  $\mu\text{m}$ ); edges with long serrations; 3, occasionally 4, compound setae on posterior parapodia (Fig. 19e, f); all blades about 8  $\mu\text{m}$  long; upper ones with long serrations; shafts of compound setae similar throughout body, stouter on posterior segments, distal ends smooth. Solitary inferior simple setae (Fig. 19h) on posterior segments, curved, as stout as superior simple setae. Acicula (Fig. 19i, j) solitary, with tips strongly bent anteriorly at slightly less than right angle in anterior parapodia, stouter, similar in shape in posterior parapodia. Spherical parapodial glands containing yellow, opaque, spherical granules always on dorsal side above each parapodial lobe medial to dorsal cirri beginning with setiger 4, with opening above dorsal cirri; glands mostly empty in one specimen, with granular particles present in and around spherical vesicles. Pygidium (Fig. 19a) hexagonal in outline with pair of long, anal cirri on posterolateral margins; transverse row of about 6 relatively long, glandular papillae dorsally in middle of lobe and 4 widely spaced terminal papillae. Sexually mature males with sex products beginning in setiger 10–11 and continuing to setiger 31 in one specimen; natatory setae on one male beginning on setiger 11, with sperm in setiger 10 in same. Females with internal eggs, 2 per segment, beginning mostly in setiger 10–11; eggs beginning in largest female (7 mm long, with 44 setigers) by setiger 12 (possibly setiger 11), extending posteriorly to setiger 32; no females with external embryos or natatory setae. Number of segments containing sexual products apparently related to animal size with posterior 10–12 segments usually empty.

Pharynx long and narrow, with relatively thick walls (usually not strongly bent or folded), mostly located in first 3 setigers and part of tentacular segment; middorsal tooth anterior, relatively large. Proventriculus cylindrical, located in most of length of setigers 4 and 5, with 13–14 irregular transverse rows of muscle cells, anterior 4–5 rows small.

*Remarks.*—I am not aware of descriptions of any *Sphaerosyllis* species having parapodial glands containing spherical granules. In view of the constancy of this character, I feel that the specimens represent an undescribed species of this genus. The specimen from North Carolina reported as *S. pirifera* by Day (1973) and Gardiner (1976) is *S. glandulata*. Note, however, that parapodial glands are not readily observable except in cleared specimens, and gland contents become coagulated in preserved specimens.

*Etymology.*—The specific name is derived from the Latin, *glandulata*, meaning glanded, and refers to the parapodial glands.

*Sphaerosyllis longicauda* Webster and Benedict, 1887

Figs. 20, 21

*Sphaerosyllis longicauda* Webster and Benedict, 1887:720, pl. 3, figs. 35–39.

*Brania* sp. Hartman, 1944:pl. 24, figs. 1, 2.

*Sphaerosyllis erinaceus*.—Pettibone, 1963:135, 136, fig. 35a [in part].—Gardiner, 1976:131, fig. 10s–v [not Claparède, 1863].

*Material examined.*—MAINE: Eastport; syntypes on 3 slides (USNM 27557) [alcoholic syntypes in poor condition (USNM 400)]. NORTH CAROLINA: Banks Channel, Wrightsville Beach, intertidal, on rocks; R. Fox, col.; 11 specimens (USNM 52915). FLORIDA: Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 2 specimens (FSBC I 20672, 20673). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 15 specimens (USNM 54525, 54526; FSBC I 20674–20681).

*Description.*—Body without color markings; integument covered with sediment. Females of Florida specimens maximally 2.6 mm long, 0.2 mm wide without parapodia, with 26 setigerous segments; males smaller, maximally 2.1 mm long, with 24 setigerous segments. Prostomium (Fig. 20a, b) oval, about 3 times wider than long, broadly fused dorsally with tentacular segment. Three pairs of lensed eyes; anterior eyes small, located in usual position of eyespots, on anterior margin of prostomial lobe medial to lateral antennae; posterior 2 pairs larger, in arc on posterior part of prostomial lobe; arc either anteriorly concave or convex depending upon state of contraction of specimen; lateral pair of eyes larger. Lateral antennae originating on anterolateral margins of prostomial lobe, with bulbous bases and cylindrical tips, often extending slightly past palps. Median antenna originating from anterior emargination of tentacular fold covering posterior part of prostomium,  $1\frac{1}{3}$  times lengths of lateral antennae, occasionally extending farther anteriorly. Palps short, dorsally fused, with wide, median, anterior notch and dorsal, median furrow, without papillae. Dorsal lobes of brain extending to anterior part of setiger 1; lateral lobes extending to about middle of same segment. Tentacular segment visible dorsally principally as fold

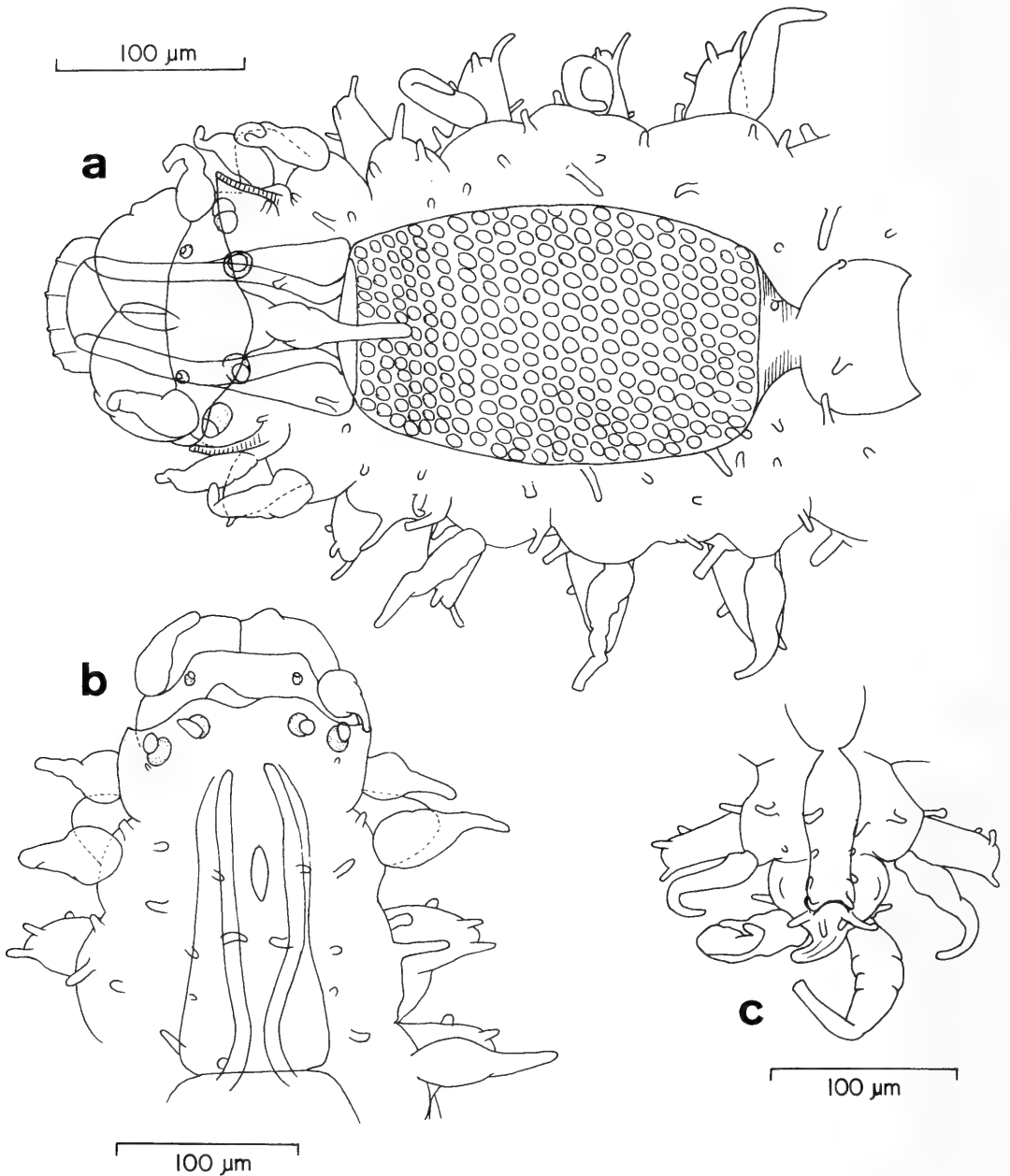


Fig. 20. *Sphaerosyllis longicauda*: **a**, Anterior end, dorsal view (USNM 54525); **b**, Same, relaxed specimen; **c**, Posterior end, dorsal view.

covering posterior half of prostomial lobe; tentacular cirri similar to lateral antennae, originating below lateral eyes; few short papillae on tentacular fold. Dorsum of each segment papillated with both long and short papillae (Fig. 20a). Dorsal cirri absent from setiger 2, replaced by glandular papillae, on remaining segments relatively slender, much longer than parapodial lobes. Parapodial lobes stout, with blunt tips, with about 4 long, prominent

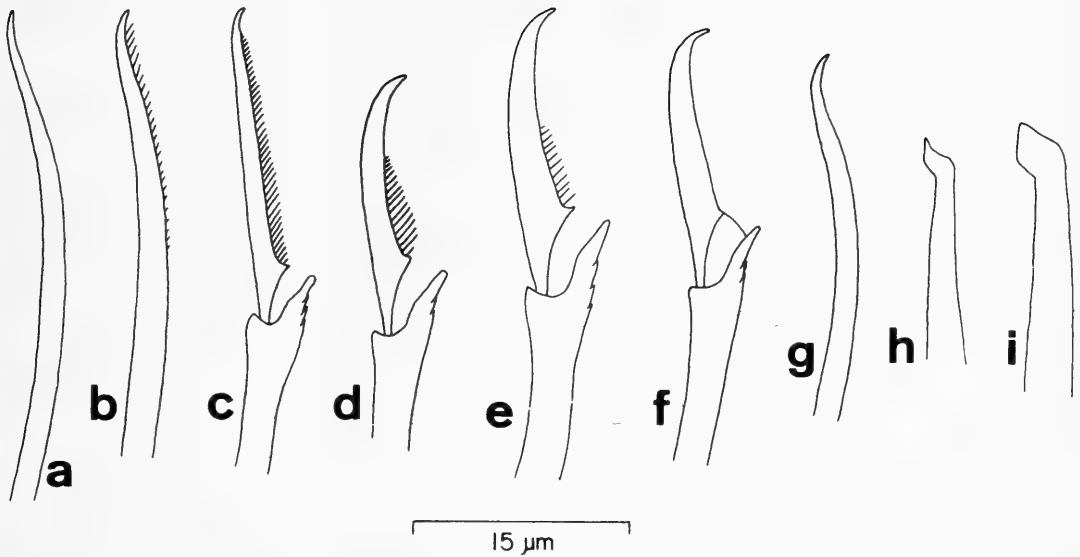


Fig. 21. *Sphaerosyllis longicauda*: a, Superior simple seta, anterior setiger; b, Same, posterior setiger; c, Upper compound seta, anterior setiger; d, Lower compound seta, setiger 10; e, Upper compound seta, posterior setiger; f, Same; g, Inferior simple seta, posterior setiger; h, Aciculum, anterior setiger; i, Same, posterior setiger.

glandular papillae; long, most prominent papilla on posterior tip; 1 each on anterodorsal part of tip, on anterior margin about half distance from base to tip, and on posterior margin near base. Ventral cirri short, cylindrical. Solitary, superior simple setae (Fig. 21a, b) on all setigers, slightly curved near tips, smooth on anterior segments, stouter and serrate on concave side near tips on posterior segments. About 7 compound setae on anterior parapodia (Fig. 21c, d), with unidentate blades; upper blades longest, 22  $\mu\text{m}$ , with fine serrations from bases to near tips; lower blades about 12  $\mu\text{m}$ , smooth. Five or 6 compound setae with similar, shorter blades, 12–15  $\mu\text{m}$  long, on posterior parapodia (Fig. 21e, f); upper blades with fine serrations or smooth; blades and shafts often stouter than on anterior segments. Distal ends of shafts of compound setae with about 3 serrations. Solitary, small, smooth, inferior simple setae (Fig. 21g) on posterior parapodia. Acicula (Fig. 21h, i) solitary, relatively slender, sharply anteriorly curved near tips, with acute tips in anterior parapodia; much stouter in posterior parapodia but similar in shape except tips not as pointed. Pygidium hemispherical, with 2 rather long, stout, lateral anal cirri about twice length of dorsal cirri and prominent, midventral projection or cirrus, with about 10 long papillae visible dorsally. Sexually mature males with sexual products beginning in setiger 8, extending to setigers 16–21. Females with 4 internal eggs or dorsal, external embryos, beginning on setigers 8 or 9, extending to setigers 16–21; single pair of embryos between parapodial lobes and dorsal cirri; second



pair above dorsal cirri; one male with natatory setae beginning on setiger 8.

Pharynx (Fig. 20a) strongly chitinized, basally surrounded by lightly colored glands, located in tentacular segment and first 2 setigerous segments of relaxed specimens, ending posteriorly in setiger 2 with anterior end extending past palps of contracted specimens, about 0.17 mm long. Middorsal tooth large, about  $\frac{1}{3}$  distance from anterior end; anterior end surrounded by stiff cylinder with about 10 papillae on margin. Proventriculus barrel shaped, located in setigers 3–5 of relaxed specimens, extending anteriorly into setiger 2 in contracted specimens. Muscle cells in dorsal view arranged in 3 planes: prominent transverse plane; 2 opposite, diagonal planes; 18–21 transverse rows; anterior 5 small.

*Remarks.*—*Sphaerosyllis longicauda* has been referred to *S. erinaceus* Claparède, 1863 (Pettibone, 1963). However, it differs from *S. erinaceus* in that the middorsal pharyngeal tooth is not at the anterior end of the pharynx, and the pygidium has a ventrally originating median anal cirrus in addition to the lateral pair. My specimens are in reasonably good agreement with types of *S. longicauda*; however, examination of critical details of the type-specimens was not possible because of poor quality of the slides, and new material from the type-locality will possibly aid in confirming this determination. Specimens reported as *S. erinaceus* by Gardiner (1976; USNM 52915) are *S. longicauda*.

*Sphaerosyllis erinaceus* Claparède (1863:45, 46, pl. 8, fig. 38) is based on a very short description of a juvenile with figures of the prostomium and pygidium only; type material has apparently been lost. It was redescribed by Saint-Joseph (1887:207, 208, pl. 10, figs. 81–83) based on a single specimen from near the type-locality. Saint-Joseph's description is in agreement with Claparède's short description and must be accepted if the species is to stand. However, paired tentacular lobes, that Saint-Joseph did not describe, have been described on specimens from other areas and referred to *S. erinaceus* (*S. longicauda*.—Eliason, 1920:11–13, not Webster and Benedict, 1887; Hartmann-Schröder, 1971:168, synonymy), and Saint-Joseph's specimen should be re-examined to determine the presence of the lobes.

*Sphaerosyllis longicauda* was originally reported from New England and is now known from North Carolina and Florida.

*Sphaerosyllis magnidentata*, new species

Fig. 22

*Material examined.*—FLORIDA: Monroe County, John Pennekamp State Park, South Creek channel marker No. 2, 3.8 m, in sand, shell, and coral rubble with *Thalassia*, *Penicillus*, and *Halimeda* cover; R. J. Helbling, col., 13 Nov. 1975; holotype (USNM 60452), 2 paratypes (USNM 60453; FSBC I 23600). Same; col., 1979; 4 paratypes (USNM 60454; FSBC I 23601). THE BAHAMAS: S portion of Bimini Lagoon, 25°43'N, 79°16'W, in sub-

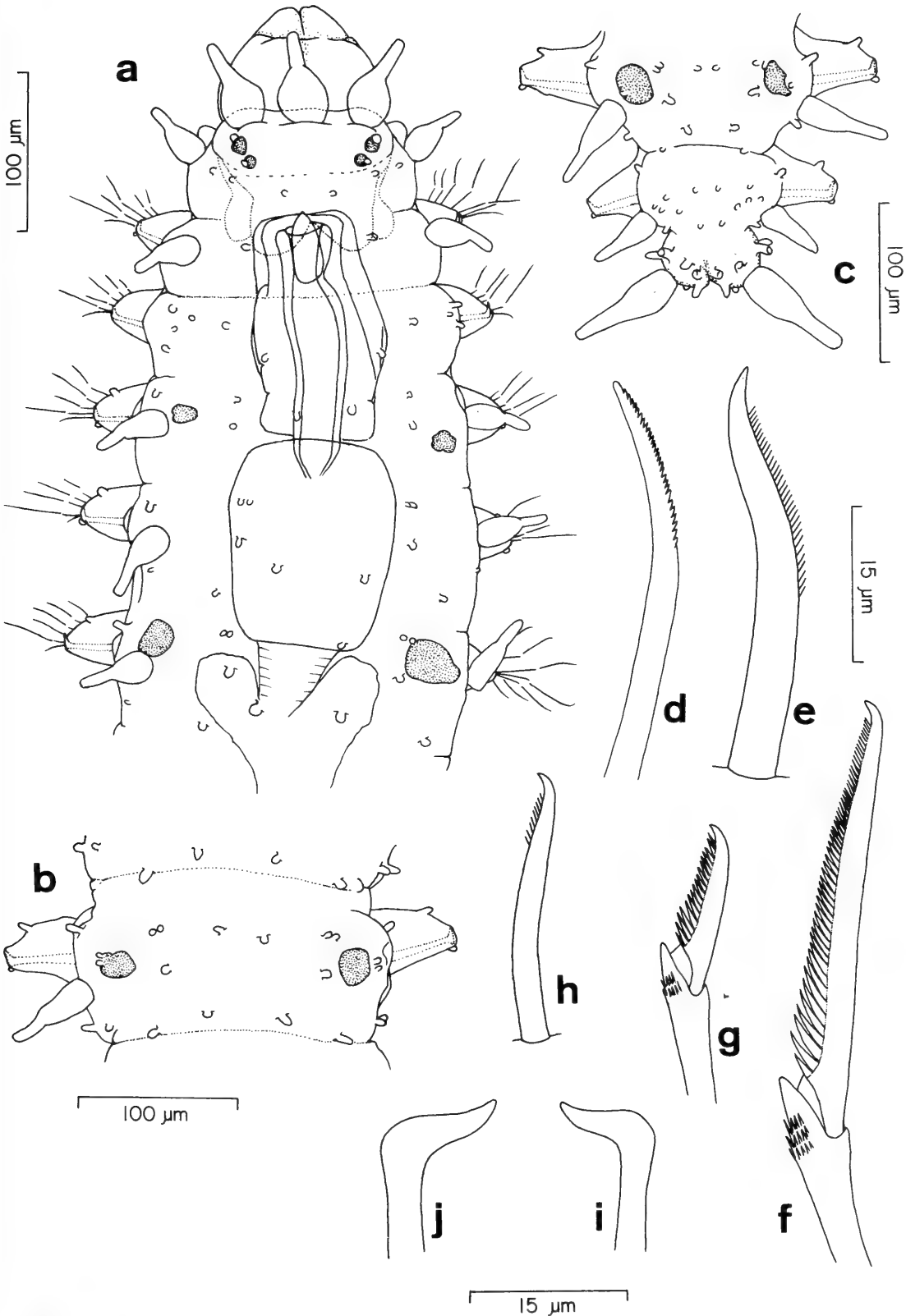


Fig. 22. *Sphaerosyllis magnidentata*: a–c, Holotype: a, Anterior end, dorsal view; b, Middle segment, dorsal view; c, Posterior end, dorsal view; d–i, Paratype (USNM 60453): d, Superior simple seta, setiger 4; e, Same, posterior setiger; f, Upper compound seta, setiger 4; g, Lower compound seta of same; h, Inferior simple seta, posterior setiger; i, Aciculum, setiger 4; j, Same, posterior setiger.

merged plastic sponges; A. Schoener, col., 1970–1971; 1 paratype (USNM 60455).

*Description*.—Body without color markings. Holotype 1.8 mm long, 0.25 mm wide including parapodia across proventriculus, 20 setigers; paratypes with 18–21 setigers. Prostomium and tentacular segment almost completely fused dorsally (Fig. 22a), separated only by obscure groove. Prostomium about 3 times wider than long with 2 pairs of relatively small, lensed eyes on posterior half in flattened trapezoidal arrangement open to front, anterior pair slightly larger. All three antennae similar, each about half as long as prostomial width, constricted at base, with globular base and cylindrical tip, all originating near anterior prostomial margin. Palps dorsally smooth, with fused part almost as wide, longer than prostomium; anterior divided parts usually turned ventrally. Dorsal lobes of brain extending to about middle of setiger 1; ventrolateral lobes slightly shorter. Tentacular segment about as long as, slightly wider than, and laterally surrounding posterior half of prostomium; tentacular cirri originating below eyes, about  $\frac{2}{3}$  lengths of antennae, similar to dorsal cirri of following segments. Six glandular papillae in transverse row above tentacular cirri. Dorsal cirri absent from setiger 2, constricted at bases on other anterior setigers, with bulbous bases and cylindrical tips, with elongate, nearly cylindrical bases and narrower, cylindrical tips on middle and posterior setigers; all extending to about tips of parapodial lobes. Dorsal parapodial glands beginning on setiger 5, possibly also on setiger 3, extending to posterior end; contents granular; dorsal opening not seen. Setal lobes relatively stout, blunt. Ventral cirri cylindrical, slender, not extending to tips of setal lobes. Solitary, superior simple setae (Fig. 22d, e) emerging above acicula on all parapodia, curved dorsally, serrate on ventral border near tips, longer and stouter on posterior setigers. About 7 compound setae on anterior parapodia, 4 on posterior parapodia (Fig. 22f, g); blades with unidentate, hooked tips; edges serrate to near tips; serrations relatively long, large, closely spaced proximally, shorter and more slender distally; upper blades long on anterior parapodia, gradually shorter below (43 and 17  $\mu\text{m}$  on setiger 4, slightly shorter anteriorly); blades similar on posterior parapodia but upper blades shorter (about 30  $\mu\text{m}$ ). Shafts of compound setae with 2 or 3 rows of serrations subdistally. Solitary, inferior simple setae on posterior parapodia (Fig. 22h), with hooked, unidentate tips, serrate near tips on concave margins. Acicula (Fig. 22i, j) solitary, stout, with tips bent forward at about right angle, slightly stouter in posterior parapodia. Glandular papillae on dorsum and parapodia of setigerous segments as figured on anterior and middle segments (Fig. 22a, b). Pygidium subspherical, with dorsal transverse row of 8 large papillae, 4 similar, terminal papillae surrounding anus; anal cirri similar in shape to dorsal cirri of posterior segments but longer and stouter. No sexually mature specimens seen.

Pharynx (Fig. 22a) about 140  $\mu\text{m}$  long, thick walled, surrounded by thick glands, extending from anterior margin of setiger 1 to near posterior margin of setiger 3; middorsal tooth anterior, massive; soft papillae surrounding anterior end possibly absent. Proventriculus short, subcylindrical, about 120  $\mu\text{m}$  long, 105  $\mu\text{m}$  wide, extending to about middle of setiger 5 in slightly less than 2 segments, with about 14 irregular, transverse rows of muscle cells, anterior 4 rows small.

*Remarks.*—*Sphaerosyllis magnidentata* resembles *S. ovigera* Langerhans (1879:567, 568, pl. 32, fig. 23; Fauvel, 1923:302–304, fig. 116a–d) in the origin of the median antenna, but differs in having smooth palps, long- and short-bladed compound setae, and parapodial glands containing granular material, not rods as in *S. ovigera*.

In addition to differences indicated in the key, *S. magnidentata* differs from other *Sphaerosyllis* species reported herein with dorsal parapodial glands and acicula bent forward at about a right angle, in having a massive middorsal pharyngeal tooth and upper compound setae with very long blades.

*Etymology.*—The specific name is derived from the Latin *magna*, meaning large, and *dentata*, meaning toothed, and refers to the large pharyngeal tooth.

*Sphaerosyllis piriferopsis*, new species  
Figs. 23, 24

*Material examined.*—FLORIDA: Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., May 1972; USNM 60210), 18 paratypes (USNM 16398; ZMH P-60211; FSBC I 23602–23608). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 21 paratypes (AHF Poly 1316; ZMH P-16399; FSBC I 23609–23617). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 6 paratypes (FSBC I 23618–23622). Monroe County, John Pennekamp State Park, South Creek channel marker No. 2, 3.8 m, in sand, shell, and coral rubble with *Thalassia*, *Penicillus*, and *Halimeda* cover; R. J. Helbling, col., 13 Nov. 1975; 1 paratype (FSBC I 23622). THE BAHAMAS: S portion of Bimini Lagoon, 25°43'N, 79°16'W, in submerged plastic sponges; A. Schoener, col., 1970–1971; 2 paratypes (USNM 54326).

*Description.*—Body without color markings; pharynx surrounded by brownish glands; dark brown eye pigment often in dorsal lobes of brain, extending posteriorly into setiger 1. Maximum length 2.3 mm, width 0.12 mm without parapodia, 30 setigers. Prostomium and tentacular segment fused (Fig. 23a, b), with tentacular segment dorsally forming fold covering posterior part of prostomium; median antenna often originating from anterior margin of fold. Prostomium about twice as wide as long, with 2 pairs

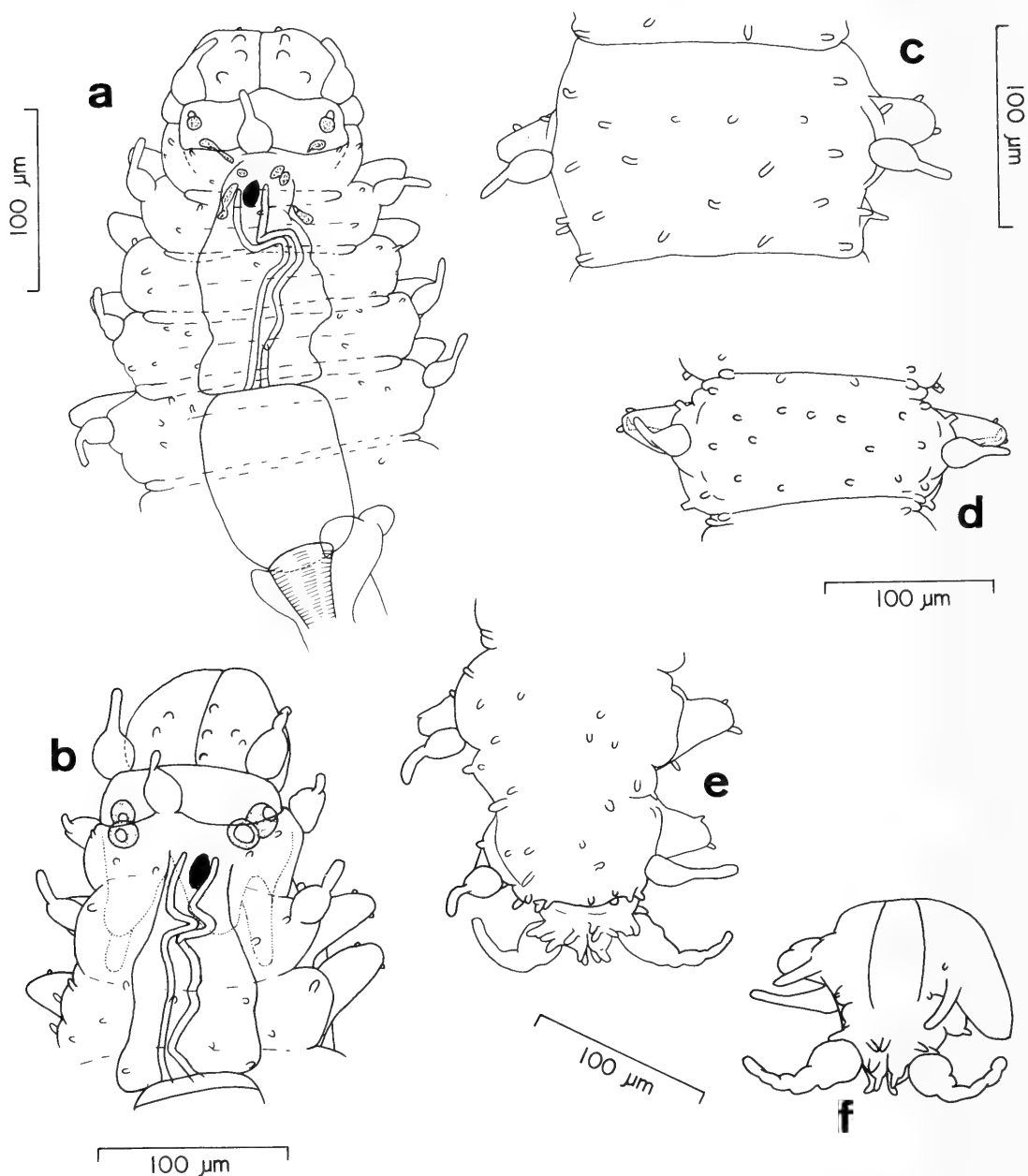


Fig. 23. *Sphaerosyllis piriferopsis*: a, Anterior end, dorsal view, pharyngeal tooth darkened (AHF Poly 1316); b, Same, holotype; c, Middle segment, dorsal view; d, Same (ZMH P-16398); e, Posterior end, dorsal view; f, Same, ventral view.

of lensed eyes on posterior half arranged in flattened trapezoid open to front; posterior pair often indistinct, possibly absent, with eye pigment in dorsal lobes of brain; anterior pair slightly larger. Lateral antennae attached on anterolateral margins, similar in shape but slightly larger than median antenna, usually not extending past palps. All antennae with bulbous bases and cylindrical tips; length of tips about equal to that of bases. Dorsal lobes

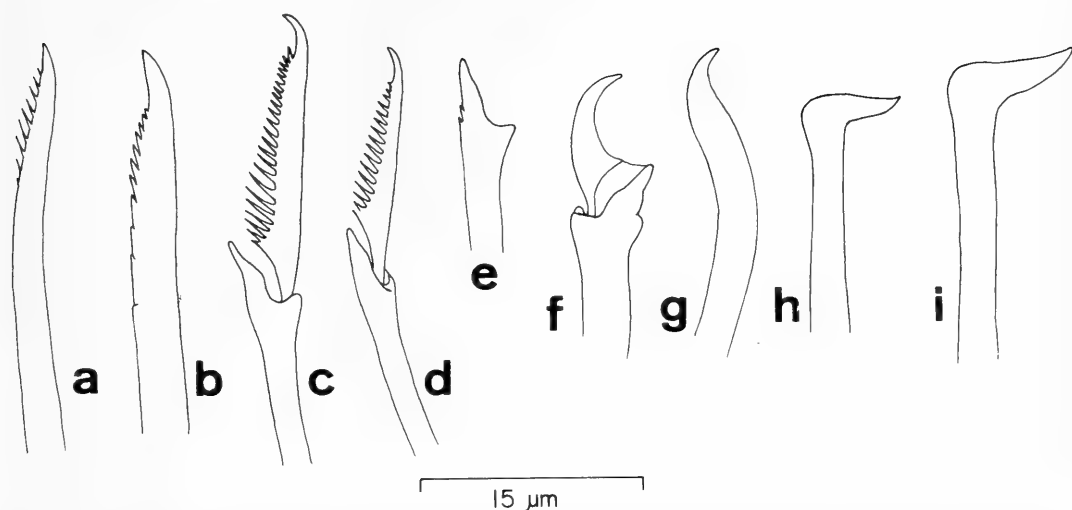


Fig. 24. *Sphaerosyllis piriferopsis*: a, Superior simple seta, anterior setiger (AHF Poly 1316); b, Same, posterior setiger; c, Upper compound seta, anterior setiger; d, Same; e, Shaft of same; f, Lower compound seta, posterior setiger; g, Inferior simple seta, posterior setiger; h, Aciculum, anterior setiger; i, Same, posterior setiger.

of brain extending to about middle of setiger 1; lateral lobes slightly longer. Palps together slightly wider and about as long as prostomium, tips usually turned ventrally, large papillae or bumps on dorsal side and smaller papillae on tips. Tentacular segment visible dorsally although fused with prostomium, enclosing lateral sides of prostomium, with several glandular papillae dorsally. Tentacular cirri usually originating ventrolateral to eyes or more anteriorly on contracted specimens, about as stout but shorter than lateral antennae. Dorsal cirri absent from setiger 2, replaced by glandular papillae. Dorsal cirri on other setigers similar to antennae but not as stout; tips extending to or slightly past parapodial tips. Parapodial lobes stout, bluntly rounded. Ventral cirri slender, cylindrical, originating near parapodial bases, not extending past tips. Small, spherical, glandular papillae on dorsum and parapodia of median segments (Fig. 23c, d). Solitary superior simple setae above acicula on all parapodia, serrate on edge near tips, slender on anterior segments, stouter on posterior segments (Fig. 24a, b). About 5 compound setae on anterior parapodia (Fig. 24c–e), about 3 on posterior parapodia; upper blades on anterior parapodia about twice as long ( $17\ \mu\text{m}$ ) as lower ones, with long, thin serrations from bases to near tips; lower blades smooth or nearly so; tips unidentate; blades of compound setae on posterior parapodia all about same length as lower ones of anterior parapodia but stouter, more strongly hooked (Fig. 24f). Shafts of compound setae similar throughout body but stouter posteriorly, with few serrations on distal ends. Solitary, inferior simple setae (Fig. 24g) on posterior parapodia, about as stout as corresponding superior simple setae but more

strongly curved. Acicula (Fig. 24h, i) solitary, relatively stout, with tips bent anteriorly at right angle; posterior acicula only slightly stouter than anterior. Dorsal parapodial glands always absent. Pygidial lobe (Fig. 23e, f) triangular in outline, with pair of anal cirri similar but longer and thicker than dorsal cirri, several relatively long, glandular papillae dorsally and ventrally between anal cirri and 4 terminal papillae. Sexually mature females with 2 external or internal embryos per segment; external embryos with 4–6 setigers each, attached ventrally by pygidium near parapodial lobes beginning on setiger 14 in some females, but on setiger 13 in one, continuing on 10 segments of one female; short natatory setae on 10 segments of one female, beginning on setiger 13. Males with sperm in setigers 11–24 and natatory setae on setigers 12–24; sperm in setiger 11 apparently originating in setiger 12.

Pharynx (Fig. 23a, b) long, narrow, thin walled, often bent from contraction in preserved specimens, usually in first 3 setigers, surrounded by prominent glands; middorsal tooth relatively large, anterior. Proventriculus shorter than pharynx, cylindrical, usually in setigers 4 and 5; 13–14 irregular, transverse rows of muscle cells, anterior 4–5 small.

*Remarks.*—*Sphaerosyllis piriferopsis* shows similarity to *S. pirifera* Claparède (1868:515, 516, pl. 14, fig. 2; Viguier, 1884:96–99, pl. 4, fig. 38, pl. 5, figs. 39–43; Fauvel, 1923:301, 302, fig. 115 l–p). However, the prostomium and tentacular segment of *S. piriferopsis* are not completely fused; yellowish “glands” in setiger 1 are absent; glandular papillae are numerous but small, and thus the body is not always encrusted with sand; compound setae are fewer in number in each parapodium (3–5 vs. 6–8) and have shorter blades (maximum length 50  $\mu\text{m}$  in *S. pirifera* according to Claparède’s apparently incorrectly scaled figure, and 23  $\mu\text{m}$  according to Viguier’s figure vs. 17  $\mu\text{m}$  in *S. piriferopsis*); and sexual products and natatory setae begin in more posterior segments of *S. piriferopsis*. All these differences appear to be reliable taxonomic characters. Yellowish “glands” of *S. pirifera* may be homologous with “lateral lobes of the brain” reported in *S. piriferopsis*. Differences between Claparède’s and Viguier’s figures of *S. pirifera*, other than length of blades of compound setae, are the presence or absence of dorsal cirri on setiger 2 and the degree of fusion of the prostomium and tentacular segment.

Further, several authors have stated their opinion that *S. hystrix* Claparède, 1863, and *S. pirifera* are synonymous, and that presence or absence of parapodial glands containing rods from setiger 4 posteriad is an unreliable specific character. This is absolutely contrary to my experience, and in my opinion, *S. pirifera* and *S. hystrix* cannot be considered synonyms.

*Etymology.*—The specific name, derived from the previously described species, *pirifera*, and the Greek suffix, *-opsis*, meaning likeness, refers to the similarity between the two species.

*Sphaerosyllis riseri*, new species

Fig. 25

*Material examined*.—FLORIDA: Monroe County, John Pennekamp State Park, South Creek channel marker No. 2, 3.8 m, in sand, shell and coral rubble, with *Thalassia*, *Penicillus* and *Halimeda* cover; R. J. Helbling, col., 10 May 1976; holotype (USNM 60471). Hutchinson Island Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 2 paratypes (USNM 54451; FSBC I 23626). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 2 paratypes (USNM 54452). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 3 paratypes (USNM 54450; FSBC I 23624, 23625).

*Description*.—Body without color markings; pharynx surrounded by brownish glands; lateral lobes of brain yellowish brown; sperm brown; ova or embryos light yellow. Minute; maximum length 1.5 mm, width 0.14 mm without parapodia, 17 setigers. Prostomium fused dorsally with tentacular segment (Fig. 25a, b); tentacular segment forming thin fold over posterior part of prostomial lobe covering posterior pair of eyes, with median antenna originating from anterior part of fold between posterior 2 pairs of eyes on relaxed specimens or slightly in front of fold on contracted specimens. Three pairs of eyes; pair of anterior eyespots adjacent to origins of lateral antennae; 2 pairs of lensed eyes on posterior half above origins of tentacular cirri, very close together laterally. Lateral antennae originating on anterior margin of prostomium on line slightly medial to posterior 2 pairs of eyes, closer to midline than lateral margins; antennae all of similar size, with bulbous bases and cylindrical tips; tips contracted into bases and distally ciliated. Dorsal lobes of brain wide, extending to posterior part of setiger 1; lateral lobes slightly longer. Palps short, each broader than long, papillate dorsally. Tentacular segment partially surrounding lateral margins of prostomial lobe; tentacular cirri similar in shape but smaller than antennae and dorsal cirri, originating on anterior part of lateral extensions. Four glandular papillae per segment on dorsum in 2 longitudinal rows plus 2 per segment occurring singly in front of dorsal cirri (Fig. 25c); 12 on ventrum in 3 transverse rows of 4 each. Dorsal cirri on all setigerous segments, similar to antennae but slightly smaller on anterior setigers, slightly longer posteriorly. Parapodial lobes short, pointed (Fig. 25a, b, e), triangular in dorsal view. Body of sexually modified regions of females often narrower, resulting from extrusion of eggs from body cavity, with parapodial lobes appearing much longer and more acutely pointed. Parapodia with anterior and posterior papillae subdistally (Fig. 25c) with posterior one closer to tips. Ventral cirri shorter than parapodial lobes, digitiform. Solitary, superior simple setae on all parapodia (Fig. 25g), smooth on anterior segments, lightly serrate near tips posteriorly. Five compound setae on anterior parapodia, 4 on posterior para-



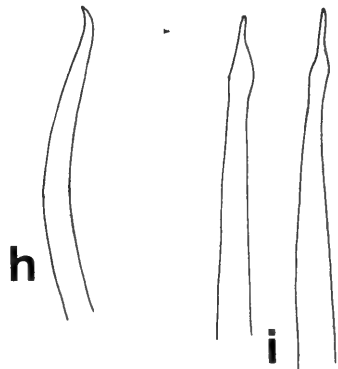
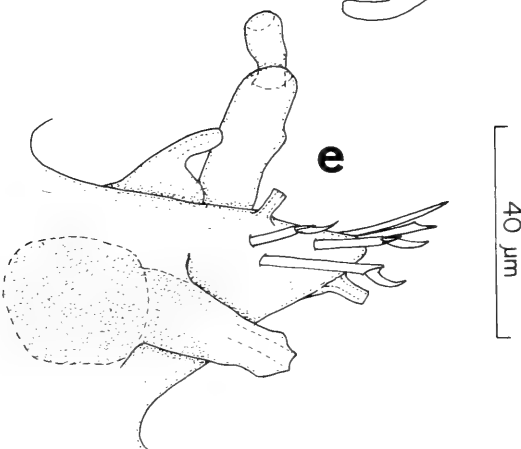
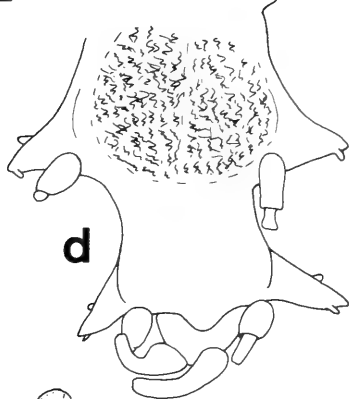
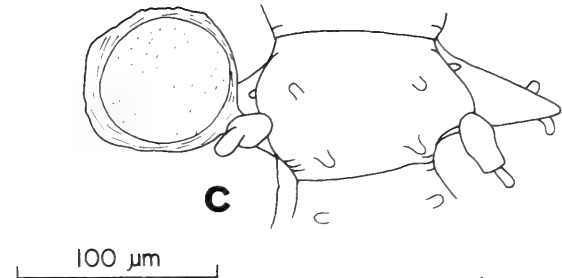
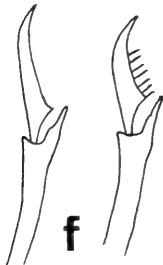
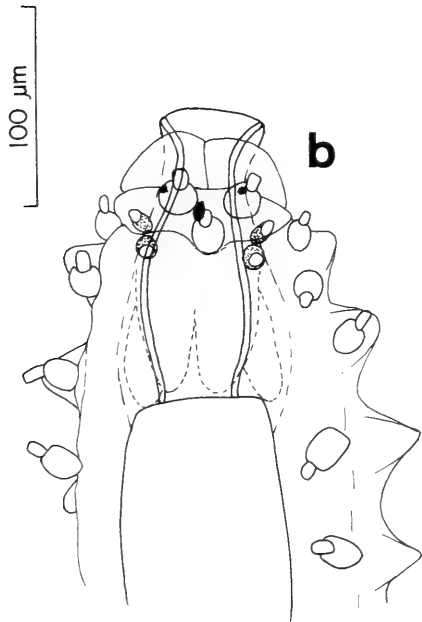
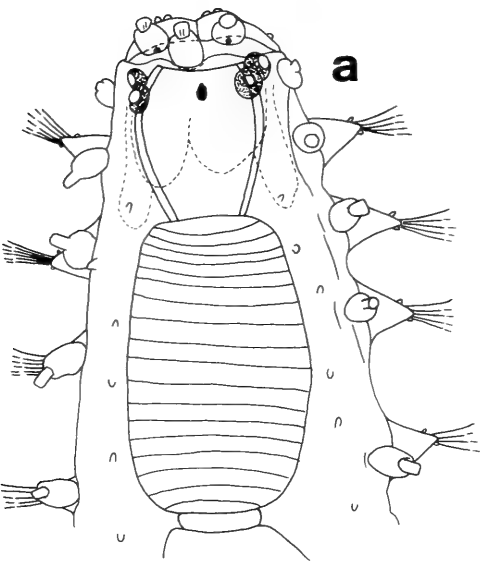
podia; all blades 7–8  $\mu\text{m}$  long, unidentate, often with fine serrations on blade edge of upper ones (Fig. 25f); blades slightly longer on first 2–3 setigers. Solitary, curved, inferior simple setae on posterior parapodia (Fig. 25h). Acicula (Fig. 25i) solitary, slender, slightly enlarged near tips; tips long, thin. Pygidium with pair of anal cirri about 3 times longer than dorsal cirri (Fig. 25d). Sexually mature specimens including 3 males and 2 females; males with brownish sperm in setigers 7–16; females with 2 spherical embryos per segment in setigers 7–13; embryos carried between parapodial lobes and dorsal cirri when external (Fig. 25c). Natatory setae not seen.

Pharynx (Fig. 25a, b) in anterior 2 setigers of relaxed specimens, extending only to middle of setiger 2 in contracted specimens, thin walled, wide, vase-shaped, with anterior opening narrower than widest part or anterior end often flared when everted; middorsal tooth minute, originating about 0.6 of distance from posterior to anterior margins. Ratio of pharynx to proventriculus lengths 1:1.1. Pharynx often turned slightly ventrally, appearing shorter in contracted specimens. Proventriculus barrel shaped, in total length of 3 segments, middle of setiger 1 to setiger 5; muscle cells arranged in 2 opposite diagonal planes in addition to more prominent transverse plane; 17–18 transverse rows of muscle cells, anterior 5–6 rows small.

*Remarks.*—*Sphaerosyllis riseri* is very similar to *S. tetralix* Eliason (1920:13–15, fig. 4; Hartmann-Schröder, 1971:165–167, fig. 54a–c). *S. riseri* is maximally 1.5 mm long with 17 setigers, while *S. tetralix* is maximally 4 mm long with 29 segments. Antennae and cirri of *S. riseri* have distal parts ciliated on the tips and strongly contracted into the bases, while on *S. tetralix* they not distally ciliated and are flask shaped, as typical of other members of the genus, on anterior segments and cirriform on posterior segments. Antennae of *S. riseri* are all similar, while the median antenna of *S. tetralix* is larger than the lateral two. Eggs and sperm first begin in setiger 7 of mature specimens of *S. riseri* and in setiger 8 of *S. tetralix*, and *S. riseri* has 2 eggs per segment vs. 4 for *S. tetralix*. The proventriculus of *S. riseri* has about 18 rows of muscle cells while that of *S. tetralix* has about 20 rows. Papillation of the dorsum is identical for the 2 species; *S. riseri* has about 12 small papillae per segment on the ventral side in regular arrangement, while *S. tetralix* was reported to have diffusely arranged papillae ventrally. Diffusely arranged papillae reported on the ventrum of *S. tetralix*

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Fig. 25. *Sphaerosyllis riseri*: a, Anterior end, dorsal view, pharyngeal tooth darkened (USNM 54450); b, Same (USNM 54451); c, Middle segment, dorsal view (USNM 54450); d, Posterior end, dorsal view (USNM 54451); e, Parapodium, ventral view (USNM 54452); f, Compound setae, setiger 7; g, Superior simple seta; h, Inferior simple seta, posterior segment; i, Acicula, dorsal and lateral views.



15  $\mu\text{m}$

indicates an irregular arrangement, but the arrangement is probably regular with numerous papillae and therefore difficult to determine.

*Etymology*.—The species is named in honor of Dr. Nathan W. Riser, who assisted me in describing this species and others.

*Sphaerosyllis taylori*, new species

Fig. 26

*Sphaerosyllis brevifrons*.—Webster and Benedict, 1884:714, 715 [in part, specimens from South Norwalk, Connecticut].

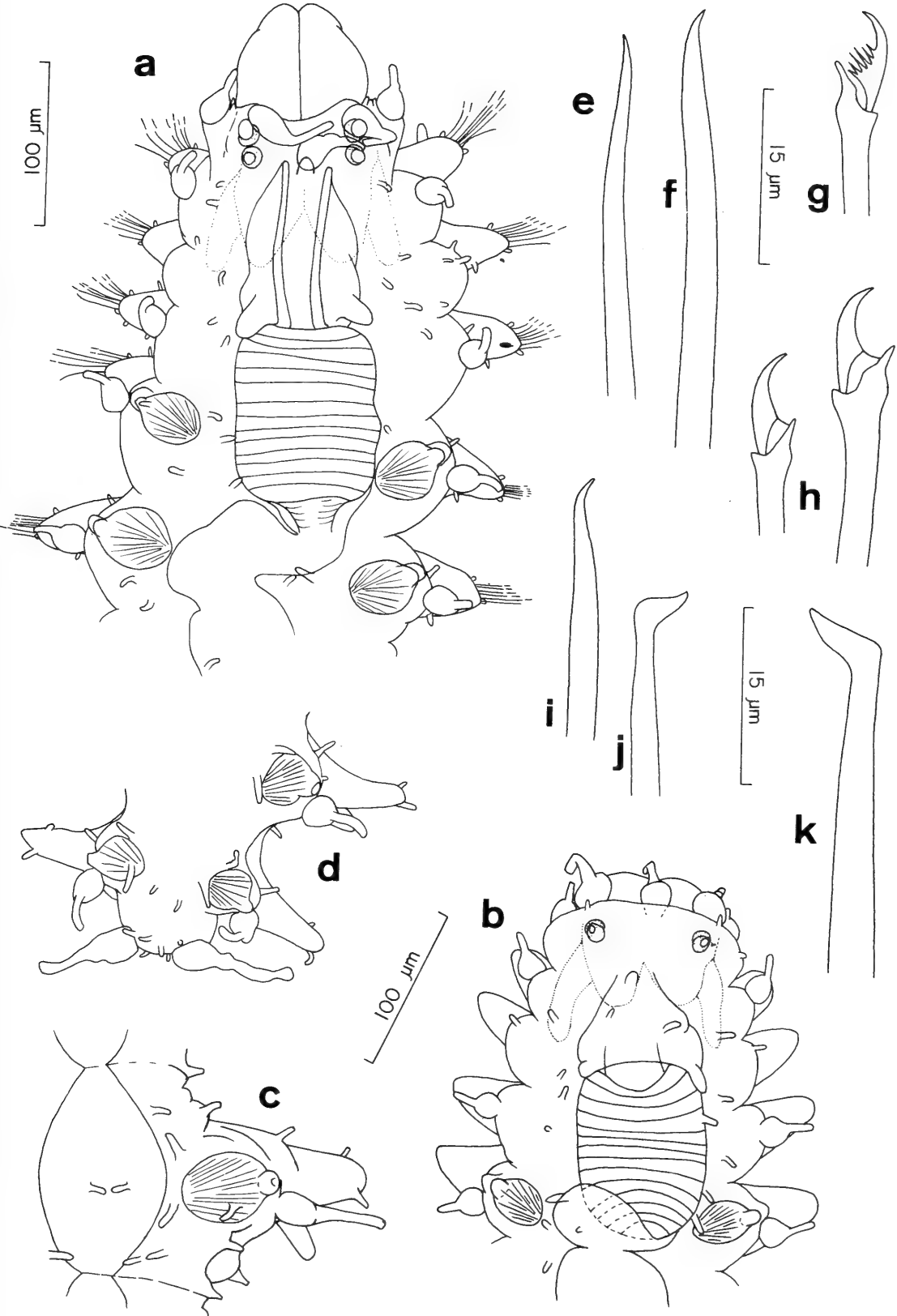
*Sphaerosyllis hystrix*.—Pettibone, 1963:136, 137, fig. 35g [not Claparède, 1863].

*Material examined*.—FLORIDA: Hutchinson Island Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Sep. 1972; USNM 60212), 33 paratypes (USNM 54522, 54524, 60213; AHF Poly 1317; ZMH P-16400; FSBC I 23627–23637). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 7 paratypes (USNM 54523; FSBC I 23638–23640). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 10 paratypes (AHF Poly 1318; ZMH P-16401; FSBC I 23641–23645). Tampa Bay, 27°34'54"N, 82°43'01"W, 7 m, sand; J. Taylor and C. Saloman, cols., 10 Oct. 1963; 3 paratypes (USNM 60214; FSBC I 23646). CONNECTICUT: South Norwalk; paratypes (USNM 27556; specimens on 3 slides originally identified by Webster as *S. brevifrons* Webster and Benedict). MARYLAND: Chincoteague Bay in *Zostera* beds; R. Orth, col., 29 Nov. 1970; 3 paratypes (USNM 44084).

*Description*.—Body without color markings; brownish glands surrounding pharynx. Maximum length 2.4 mm, width 0.2 mm without parapodia, 24 setigers. Prostomium and tentacular segment almost completely fused dorsally (Fig. 26a, b). Two pairs of lensed eyes on posterior half, very close together laterally, in nearly rectangular arrangement, anterior pair slightly larger. Lateral antennae originating on anterolateral margin of prostomium in front of eyes, with bulbous bases and cylindrical tips; lengths slightly less than distance between right and left eyes. Median antenna originating between posterior pair of eyes of relaxed specimens, often attached to anterior

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Fig. 26. *Sphaerosyllis taylori*: a, Anterior end, dorsal view (USNM 54524); b, Same, contracted specimen (USNM 54522); c, Parapodium, middle segment, dorsal view (USNM 54524); d, Posterior end of holotype, dorsal view; e, Superior simple seta, anterior setiger; f, Same, posterior setiger; g, Upper compound seta, anterior setiger; h, Compound setae, posterior setiger; i, Inferior simple seta, posterior setiger; j, Aciculum, anterior setiger; k, Same, posterior setiger.



part of tentacular fold on contracted specimens; antennae similar in length or median slightly shorter. Dorsal and lateral lobes of brain extending to anterior part of setiger 2 of relaxed specimens, extending only into setiger 1 of contracted specimens. Palps together about as wide as prostomium, exceeding length of lateral antennae by about half in extended specimens, with tips mostly bent ventrally. Tentacular segment completely enclosing lateral margins of prostomium, with few, glandular papillae below tentacular cirri and on dorsum; tentacular cirri originating on about same transverse line as lateral antennae, similar to dorsal cirri, about as thick as antennae but shorter. Dorsum of each segment with about 20 long, glandular papillae in characteristic arrangement (Fig. 26c). Dorsal cirri absent from setiger 2, replaced by glandular papillae; dorsal cirri of other setigers with bulbous bases and cylindrical tips often extending past tips of parapodial lobes. Parapodial lobes stout, blunt; each with 2 apical papillae, anterior one slightly below tip on ventral side; posterior one nearer to tip, nearly dorsal in position, 2 other papillae anteriorly and posteriorly below dorsal cirrus (Fig. 26c). Ventral cirri cylindrical, not extending past tips of parapodial lobes. Solitary, smooth, slightly curved, superior simple setae on all parapodia (Fig. 26e, f), slender anteriorly, much stouter posteriorly. Blades of compound setae (Fig. 26g, h) all similar in size, 10–8  $\mu\text{m}$  long dorsally to ventrally on anterior parapodia, similar in shape except upper ones of anterior parapodia with about 6 long, fine serrations on edge; all unidentate. Shafts of compound setae mostly stouter on posterior segments. Solitary, inferior simple setae (Fig. 26i) on posterior parapodia, slightly slenderer than corresponding superior simple setae. Acicula (Fig. 26j, k) solitary, bent forward near tips at about right angle; tips pointed; relatively slender in anterior segments, about twice as stout in posterior segments. Spherical to oblate parapodial glands containing needle-like rods; glands always above parapodial lobes medial to dorsal cirri beginning on setiger 4, with dorsal opening slightly in front of and medial to origins of cirri. Pygidium (Fig. 26d) short, bluntly rounded, with pair of anal cirri similar in shape but about twice as large as posterior dorsal cirri, with about 6 glandular papillae on dorsal side. Sexually mature males with sex products beginning in setiger 6 or 7, extending to setiger 20, but usually to about setiger 15. Natatory setae on some males beginning on segment following that with sex products, usually setiger 7. Females with internal ova beginning in setiger 7 or 8, extending to about setiger 15; none with externally attached embryos or natatory setae.

Lengths of pharynx and proventriculus (Fig. 26a, b) about equal. Pharynx in setigers 1 and 2, surrounded by thick glands, often lobed about middle; middorsal tooth anterior. Proventriculus cylindrical, not much longer than wide, usually, if not always, within setigers 3 and 4, with 13–14 very irregular, transverse muscle cell rows, anterior 4–5 rows small.

*Remarks.*—*Sphaerosyllis taylora* differs from European descriptions of *S.*

*hystrix* Claparède (1863:45, pl. 13, figs. 36, 37; Fauvel, 1923:301, fig. 115g, h; not i, k; Hartmann-Schröder and Stripp, 1968:13, 14, fig. 6a–c; Hartmann-Schröder, 1971:67, fig. 54d–f; 1974a:197) in having a pharynx and proventriculus of nearly equal length, compound setae with shorter blades with fewer serrations and of similar length in each parapodium and throughout the body, smooth, superior simple setae on all parapodia, and in being smaller with fewer segments.

Claparède's figure (1863:fig. 36) of the anterior end of *S. hystrix* shows the pharynx in almost 3 segments and the proventriculus in setigers 3 and 4. Fauvel's figure (1923:fig. 115g), attributed to Claparède, shows the pharynx occupying three segments and the proventriculus about two segments long mostly in setigers 5 and 6. Figures of Hartmann-Schröder and Stripp (1968) and Hartmann-Schröder (1971) show compound setae to be larger with many more serrations than those of *S. taylori*, and superior simple setae with a denticulate ventral margin. Claparède's figure (1863:fig. 36) shows only compound setae on anterior parapodia; Fauvel's figure (1923:fig. 115h), attributed to Claparède, shows only compound setae on a sexually modified parapodium. Fauvel (1923) and Hartmann-Schröder (1971) stated that superior simple setae were present on middle and posterior segments; Hartmann-Schröder (1971) stated that blades of compound setae were moderately long to short.

There are obvious problems with other European descriptions of *S. hystrix*. Saint-Joseph (1887:204–207) reported 2 larval forms with 2 modes of ventral incubation of embryos, and embryos first occurring on different segments on specimens from Dinard, France. The description of McIntosh (1908:156–159, pl. 59, figs. 3, 4, 8; pl. 70, fig. 1; 1910:pl. 79, figs. 11–13) included specimens with both dorsal and ventral incubation of embryos, and is so confused that it can be ignored. Southern (1914:19, 20) reported females from Ireland with both 2 and 4 eggs per segment in setigers 8–19 and males with natatory setae beginning on setigers 10 or 11. It appears certain that the accounts of Saint-Joseph, McIntosh and Southern each referred to more than one species, and their specimens should be reexamined.

*Etymology*.—It is a pleasure to name this species in honor of Dr. John L. Taylor, who assisted in the Hutchinson Island study, and has been of much help to me by providing specimens and advice.

*Streptosyllis* Webster and Benedict, 1884

*Streptosyllis pettiboneae*, new species

Figs. 27, 28

*Material examined*.—FLORIDA: Hutchinson Island Sta. III, 27°22.0'N, 80°12.4'W, about 7 m, medium calcareous sand; holotype (R. Gallagher, col., Sep. 1971; USNM 60448), 7 paratypes (USNM 60450; AHF Poly 1319;

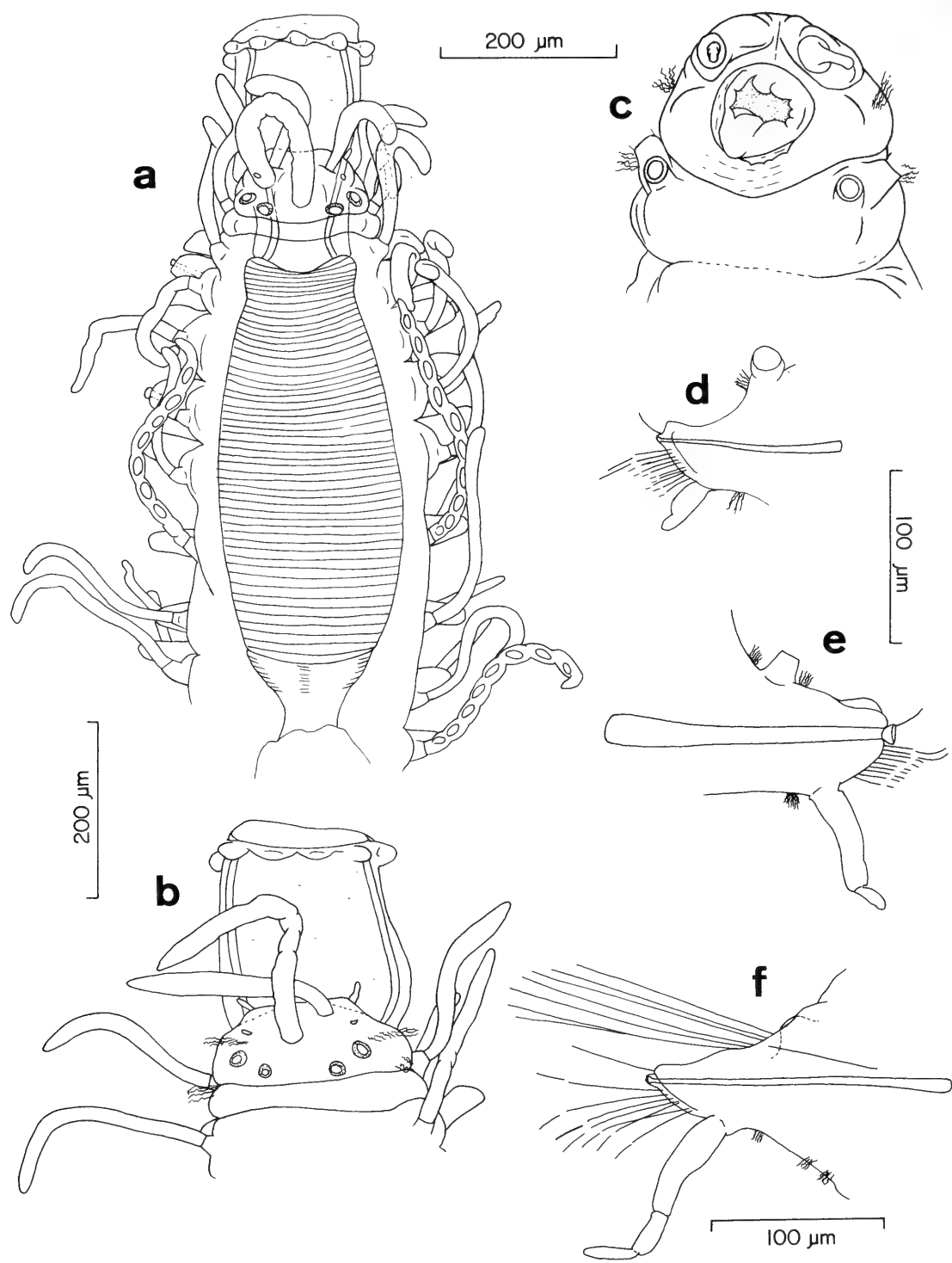


Fig. 27. *Streptosyllis pettiboneae*: a, Anterior end, dorsal view; b, Same; c, Anterior end, ventral view; d–f, Parapodia (FSBC I 23648): d, Setiger 1, anterior view; e, Setiger 3, posterior view; f, Setiger 20, anterior view.

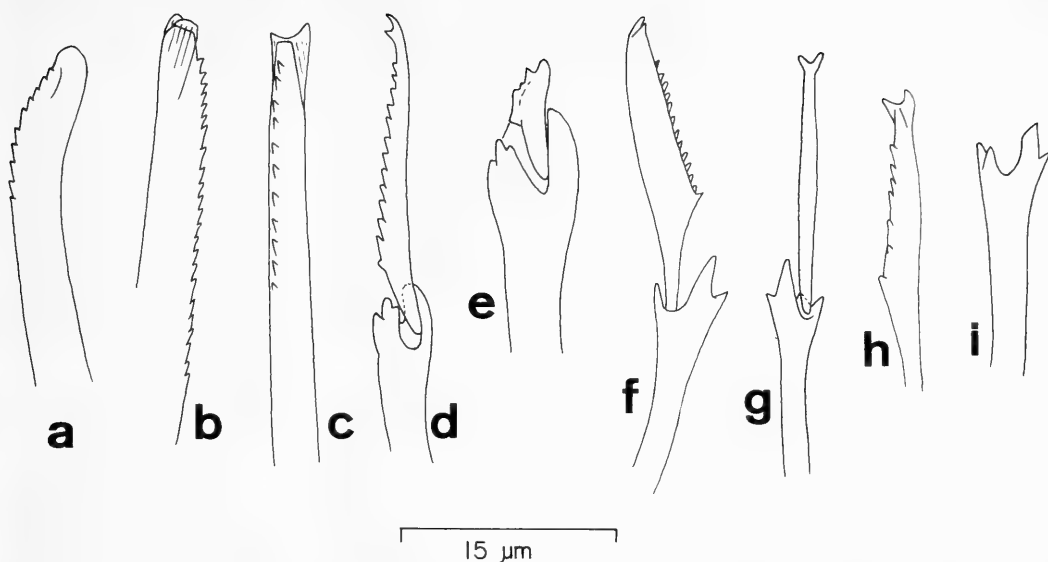


Fig. 28. *Streptosyllis pettiboneae*: a, Superior simple seta, anterior setiger; b, Same, middle setiger, lateral view; c, Same, ventral view; d, Upper compound seta, anterior setiger; e, Lower compound seta, anterior setiger; f-i, Compound setae, middle segments: f, Lateral view (of blade); g, Dorsal view (of blade); h, Lateroventral view of blade; i, Shaft.

ZMH P-16402; FSBC I 23647-23649). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 1 paratype (USNM 60449). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 2 paratypes (FSBC I 23650, 23651). Tampa Bay, 27°36'56"N, 82°41'05"W, 9 m, sand; J. Taylor and C. Saloman, cols., 25 Oct. 1963; 3 paratypes (USNM 60451).

**Description.**—Pharynx uncolored to reddish brown or brown. Largest specimen slightly greater than 4.0 mm long, width 0.9 mm without parapodia across proventriculus, 48 setigers. Prostomium (Fig. 27a, b) pentagonal; width less than twice length; posterior border slightly convex. Mature specimens with 3 pairs of lensed eyes; anterior pair small, lateroposterior to origins of lateral antennae; 2 posterior pairs larger, arranged in flattened trapezoid open to front; interior pair on posterior margin. Antennae smooth; median antenna originating between posterior 2 pairs of eyes; origins of lateral antennae near anterior margin of prostomium at middle of each side, anteromedial to anterior pair of eyespots; shapes and lengths of antennae variable; shape cylindrical to clavate, with median usually longer than prostomial width, longer and stouter than lateral antennae. Palps (Fig. 27b, c) composed of 2 distinct parts, pair of cushion-shaped ventral lobes and pair of filiform lobes emanating from middle of cushion-shaped lobes; cushion-shaped lobes rarely visible from dorsum; filiform lobes relatively long, often observable below anterior pair of eyes when pharynx everted. Rows of cilia on prostomium in front of anterior pair of larger eyes and on posterolateral



margins. Prostomial integument light brown, appearing glandular. Tentacular segment with same integumental consistency as prostomium; length depending on state of eversion of pharynx and state of contraction of specimen, short when pharynx everted, always visible dorsally. Tentacular cirri not articulate, directed slightly anterolaterally; dorsal tentacular cirri from slightly longer to almost twice as long as ventral tentacular cirri. Dorsal cirri (Fig. 27a) of anterior 5 setigers not articulate, similar to dorsal tentacular cirri and lateral antennae, with short cirrophores; becoming slightly longer, almost as long as body width after setiger 5; articulate on setiger 6; smooth or only wrinkled on setigers 7 and 8; thereafter alternately articulate and smooth or only wrinkled to posterior end; articulate dorsal cirri with 9–10 articles; each article containing 2 large cells of granular material; smooth dorsal cirri long, clavate to cylindrical, diameter slightly less than, and lengths equal to articulated dorsal cirri. Parapodial lobes (Fig. 27d–f) blunt, much stouter on setigers 2–5 than on other setigers. Ventral cirri attached near lower compound setae, about as long as parapodial lobes, slightly constricted at bases, with stout bases and long, slender tips. Solitary, superior simple setae on all parapodia (Fig. 28a–c) short, stout, without hyaline hoods, abruptly bent near tips, serrate on ventral edge near tips on setigers 1–5; after setiger 5 longer, more slender, serrate on ventral borders near tips, with short, distally bifid, hyaline hoods. Compound setae of first 5 setigers (Fig. 28d, e) including 1–3 upper, long-bladed falcigers, 10–12 lower, stout, short-bladed falcigers; long blades serrate on edge, with slender, bidentate tips; shafts of long-bladed falcigers with longest part smooth, shortest part trilobed; short falcigerous blades stout, bidentate, with 2 serrations below secondary tooth; shafts of short-bladed falcigers similar to those of long-bladed ones but stouter. Compound setae behind setiger 5 (Fig. 28f–i) relatively long falcigers; blades flattened, serrate on edge; tips unequally bifid in plane perpendicular to narrow axis of blades; bifid tips in ventral view appearing hooded or encapsulated; shafts distally with 1 long and 3 short, pointed lobes. Inferior simple setae absent. Acicula solitary, greatly enlarged and emergent in setigers 2–5, with knobbed tips. Patches of cilia medial to dorsal and ventral cirri, apparently also continuing onto dorsum and ventrum of each segment. Pygidium triangular in outline, with short, ventrally originating median cirrus; one specimen with single long, slightly thicker lateral cirrus about as long as last 8 segments. Sexually mature specimens with sexual products beginning in setigers 13–14, extending to near posterior end, often “spilling over” from originating segments into adjacent anterior or posterior segments, appearing similar in all specimens. Natatory setae, when present, either long or short (probably indicating females and males), usually beginning on segment after appearance of internal sexual products, usually on all segments containing sexual products. Solitary, slender notoacacula in parapodia with natatory setae.

Pharynx (Fig. 27a, b) broad, much shorter than proventriculus, often bent, extending from mouth to anterior part of setiger 3 when inverted, extending to about anterior part of setiger 1 when everted; 10 soft papillae around anterior end; chitinous part often everted past soft papillae by as much as half total length; middorsal tooth absent. Proventriculus long, barrel-shaped, in 6 segments, setigers 3–8 or 2–7, with about 55 rows of muscle cells.

*Remarks.*—*Streptosyllis pettiboneae* is similar to *S. websteri* Southern (1914:26–28, pl. 2, fig. 3) and differs in the following characters: longer compound setae of setigers 1–5 have bidentate blades; shafts of compound setae behind setiger 5 are not serrate near the tips; blades of compound setae after setiger 5 appear unidentate, but tips are covered by hyaline hoods which are distally bifid; hoods of superior simple setae are concave on tips; some dorsal cirri behind setiger 5, in alternate arrangement, are distinctly articulate; and sexual modification first appears on a more posterior segment, setigers 13–14 vs. 11 for *S. websteri*.

*Etymology.*—The species is named in honor of Dr. Marian H. Pettibone in an attempt to express my sincere appreciation for all the help she has provided me during the last several years.

*Syllides* Örsted, 1845

*Syllides bansei*, new species

Figs. 29, 30

*Material examined.*—FLORIDA: Hutchinson Island Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Nov. 1972; USNM 60440), 9 paratypes (AHF Poly 1320; ZMH P-16403; FSBC I 23653–23659). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 3 paratypes (AHF Poly 1321; ZMH P-16404; FSBC I 23660). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 1 paratype (AHF Poly 1322). Tarpon Springs, Anclote Anchorage, 28°12.6'N, 82°47.4'W, 2.5 m, sand with *Syringodium* cover; J. Studt and R. Ernest, cols., 17 Jan. 1975; 12 paratypes (USNM 60441). Same, 28°12.6'N, 82°46.7'W, 1.5 m, sand with *Halodule* cover; 17 Jan. 1975; 1 paratype (FSBC I 23661). Same, 28°12.5'N, 82°46.5'W, 0.5 m, sand; 5 Dec. 1975; 1 paratype (FSBC I 23662).

*Description.*—Interior body (sexual?) contents brown after first several segments; pharynx surrounded by brown glands. Maximum length 2.5 mm, 30 setigerous segments. Prostomium (Fig. 29a–d) about 2½ times wider than long; anterior margin projecting as obtuse angle; lateral margins rounded; posterior margin straight or concave. Two pairs of large, lensed eyes on posterior half; anterior pair larger, on lateral margins; smaller pair near posterior margin in about middle of each side; pair of eyespots almost always on anterior margin on line between 2 larger pairs, slightly lateral to

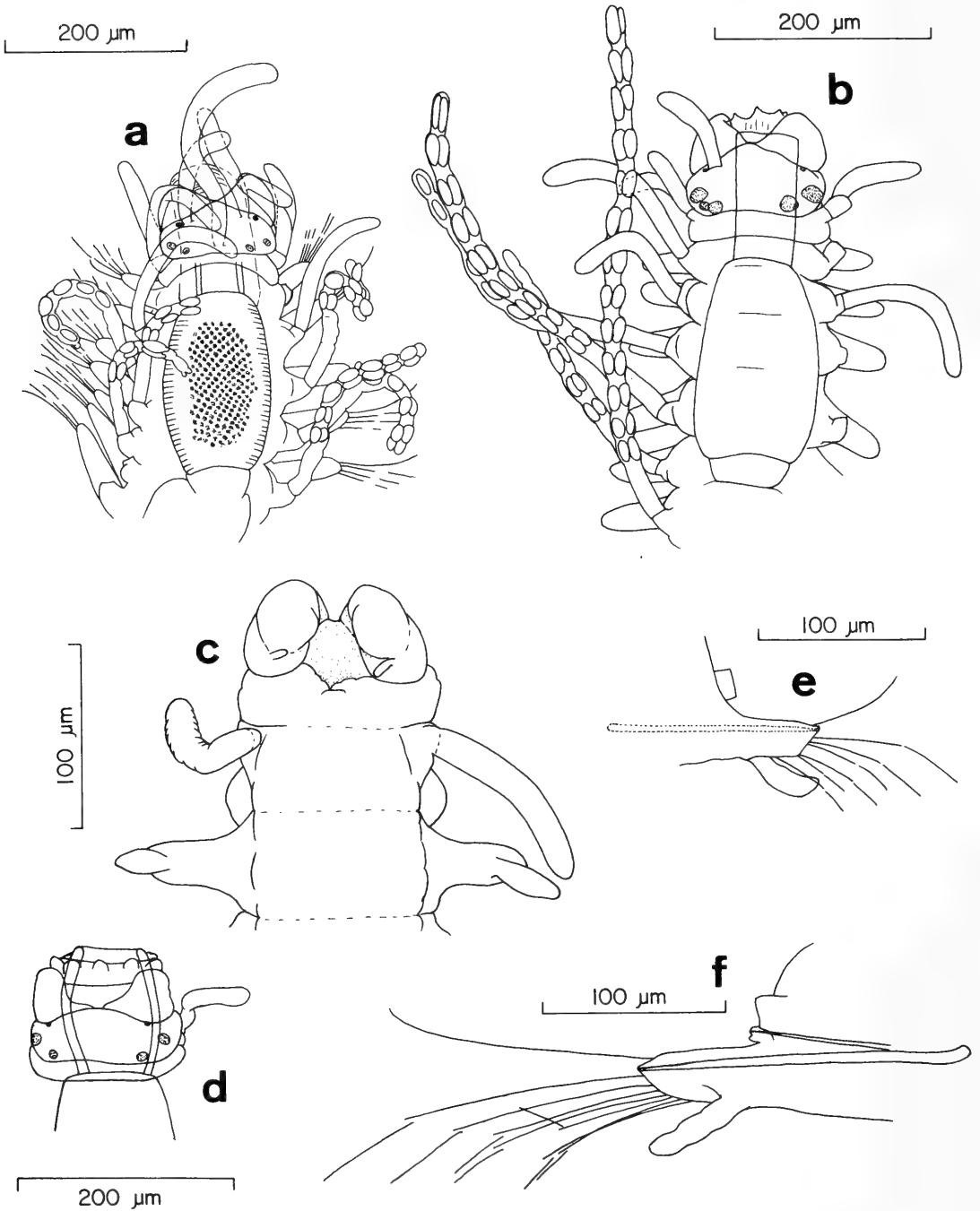


Fig. 29. *Syllides bansei*: a, Anterior end, dorsal view; b, Same; c, Anterior end, ventral view; d, Anterior end, dorsal view; e, Parapodium, setiger 2, anterior view; f, Same, middle setiger, posterior view.

origins of lateral antennae. Lateral antennae originating on anterior margin at about middle of each side, about as long as prostomium plus palps; median antenna originating between posterior pair of eyes,  $1\frac{1}{2}$  to 2 times longer than lateral antennae. Antennae, tentacular cirri, and dorsal cirri of first 2

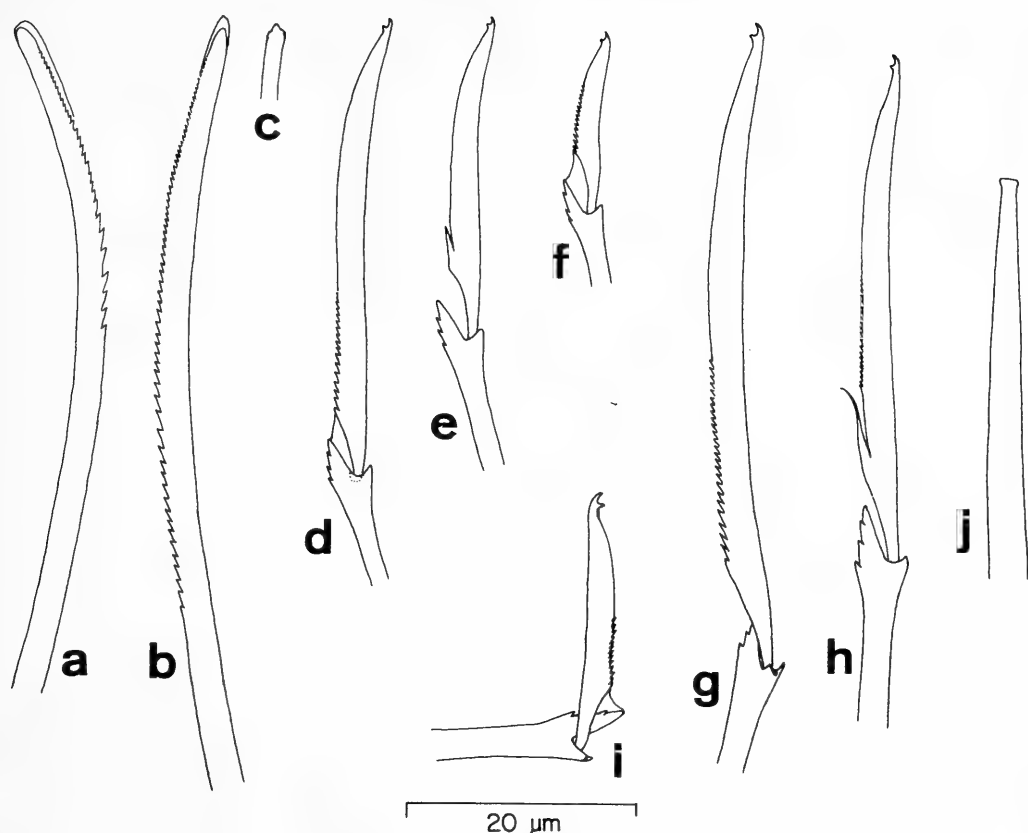


Fig. 30. *Syllides bansei*: **a**, Superior simple seta, anterior setiger; **b**, Same, middle setiger; **c**, Tip of same, dorsal view; **d-i**, Compound setae: **d**, Upper, anterior setiger; **e**, Middle of same; **f**, Lower of same; **g**, Upper, middle setiger; **h**, Middle of same; **i**, Lower of same; **j**, Aciculum, anterior setiger.

setigerous segments smooth or only wrinkled. Palps in dorsal view not appearing medially fused; each subtriangular, slightly shorter than length of prostomium; anterior edges often ventrally turned; lateral edges always ventrally turned; pair of small digitiform appendages ventroposteriorly (Fig. 29c). Tentacular segment shorter than following segment, definitely separated by grooves from prostomium and setiger 1. Dorsal tentacular cirri similar to median antenna and dorsal cirri of setigers 1 and 2; ventral tentacular cirri similar to lateral antennae. Dorsal cirri after first 2 setigers articulate, maximally with 20 articles; basal parts smooth or pseudoarticulated; articles composed of 2 oval cells containing material of mostly uniform texture and grey-green color. Parapodial lobes (Fig. 29e, f) well extended from body, almost half as long as body width; tips rounded in dorsal view, obliquely truncate laterally at greater or lesser angle to ventrum. Ventral cirri originating from about middle of lower margins of parapodial lobes; anterior 5 pairs clavate, short, stouter than following; more posterior ventral cirri longer, more filiform. Solitary, superior simple setae on all setigers

(Fig. 30a, b), slightly curved toward dorsum, lightly serrate on convex edge for about half emergent length; tips covered by slightly expanded, evenly rounded, hyaline hoods; setae shorter, stouter than following, abruptly tapering in width only near tips on first 5 setigers, gradually tapering toward tips more posteriorly. Compound setae similar in shape and number in all but last few parapodia, 7–9 in anterior parapodia, 5–7 in posterior parapodia, longer on middle parapodia than on setigers 1–5. Blades of compound setae 26–65  $\mu\text{m}$  long, of 3 basic types (Fig. 30d–i), all bidentate; upper blades usually solitary, often absent, long, lightly serrate on basal half; middle blades, 2–3, intermediate in length, with single, basal spur, otherwise smooth (very fine serrations may be present above spur); lower blades, 3–5, similar to upper blades but shorter than upper and middle types. Shafts of compound setae similar throughout body; distal end serrate in side view, pointed; short part of hinge broader than remainder of shaft in plane view. Inferior simple setae absent. Acicula (Fig. 30j) (neuroacicula) solitary, similar in size and shape throughout body, relatively slender, gradually narrowed to slightly enlarged tips; tips truncate or slightly concave, appearing ragged. Slender notoacicula in sexually modified segments of adults beginning in parapodia of setigers 8 or 9, extending to 2–3 segments from pygidium. Pygidium with paired lateral anal cirri apparently lost; several specimens with slender, short median anal cirrus. Single sexually mature specimen with 3–5 very short natatory setae on parapodia of setigers 11–29; no specimens with internal eggs or external embryos; sexual products in segments with notoacicula.

Ratio of pharynx to proventriculus lengths about 2:3; pharynx (Fig. 29a, b, d) thickly chitinized, slightly less than twice long as wide, without mid-dorsal tooth, surrounded anteriorly by about 10 semicircular, soft papillae proximal to smooth anterior end of chitinous part when completely everted. Proventriculus barrel-shaped, about  $1\frac{1}{2}$  times longer than wide, occupying 3– $5\frac{1}{2}$  segments depending on size of specimen and state of eversion of pharynx, usually ending near posterior part of setiger 5, with 35 transverse rows of muscle cells, also arranged in 2 opposite, diagonal planes (Fig. 26a).

*Remarks.*—The genus *Syllides* Örsted, 1845, was recently reviewed by Banse (1971). *S. bansei* is similar to *S. benedicti* Banse (1971:1478, 1479, fig. 6), differing in the following characters: smaller size (2.5 mm vs. 6.5 mm); smaller maximum number of segments (30 vs. 70); smaller length to width ratio of proventriculus (1.5:1 vs. 3:1); more anterior position of proventriculus (ending at posterior part of setiger 5 vs. about setiger 10 for *S. benedicti*); shape of tips of superior simple setae; fine detail of blades of upper and lower compound setae (finely toothed in *S. bansei* vs. smooth); and possibly in shape of tips of shafts of compound setae.

*Etymology.*—The species is named in honor of Dr. Karl Banse, whose review of the genus facilitated the description of this species.

*Syllides floridanus*, new species

Figs. 31, 32; Table 1

*Material examined*.—FLORIDA: Hutchinson Island Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Nov. 1971; USNM 60438), 2 paratypes (USNM 60439). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 1 paratype (FSBC I 23663).

*Description*.—Articulate dorsal cirri brownish yellow; middle and posterior segments often dark yellow, possibly from sexual products. Dimensions: see Table 1. Prostomium (Fig. 31a, b) about twice as wide as long, pentagonal, anterior margin forming obtuse angle, lateral margins almost straight, posterior margin straight or convex. Three pairs of lensed eyes; posterior 2 pairs on posterior half of prostomial lobe, in trapezoidal arrangement, with posterior ones about equidistant between origin of median antenna and lateral pair of eyes; lateral pair near middle of lateral margins; anterior pair small, on anterior margin on line between 2 posterior pairs, often damaged. Median antenna originating between lateral pair of eyes, all missing. Lateral antennae originating between median antenna and anterior pair of eyes, slightly nearer to anterior eyes than median antenna; length about 0.18 mm, equal to prostomial width or slightly less. Palps (Fig. 31a–c) short, triangular, not appearing medially fused; pair of digitiform appendages ventrally on lateroposterior parts. Lateroanterior prostomial margins ciliated. Texture of dorsal surface of prostomium glandular. Tentacular segment slightly shorter than following segment; dorsal tentacular cirri about twice longer than lateral antennae (0.24:0.13 mm); ventral tentacular cirri shorter than dorsal; texture of integument glandular, same as that of prostomium. Dorsal cirri of setigers 1 and 2 smooth or only wrinkled; long on setiger 1 (0.5 mm), much shorter (0.3 mm) on setiger 2. Articulated dorsal cirri beginning with setiger 3 (Fig. 31b), continuing to posterior end, with maximum of 20 articles; articles distinct from proximal parts, each composed of 2 cells containing numerous particles showing granular appearance. Parapodial lobes (Fig. 31d, e) long, cylindrical; dorsal anterior lobe on end; rows of cilia above and below apparently also extending across dorsum of each segment. Ventral cirri originating from about middle of ventral border of parapodia, extending laterally to parapodial tips, subulate. Solitary, superior simple setae (Fig. 32a, b) on all parapodia, long, slender, fine tipped, distally serrate, basally rounded; serrate parts flattened; tips slightly hooked, capitate. Compound setae (Fig. 32c–i) long falcigers, 9–10 in each parapodium; blades bidentate, distal teeth similar in size, primary tooth strongly hooked, secondary tooth pointed; upper blades 1–2 per parapodium (often absent), serrate on proximal third, 80–100  $\mu$ m long, with basal serrations only slightly enlarged; blades below upper ones with about 3 long,

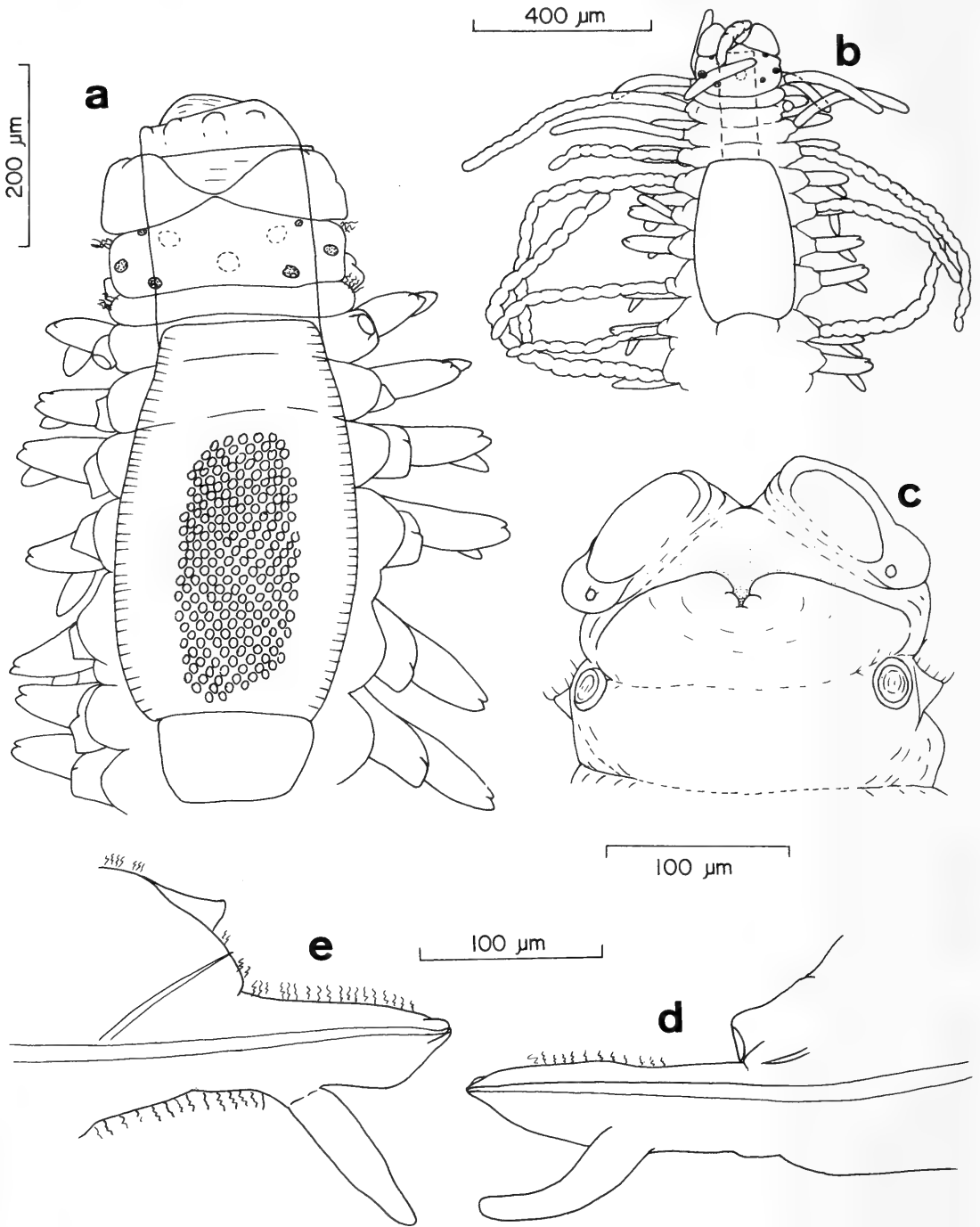


Fig. 31. *Syllides floridanus*: a, Anterior end, dorsal view; b, Same, holotype; c, Same, ventral view; d, Parapodium, setiger 10, anterior view; e, Same, setiger 22, posterior view.

basal spines more or less parallel to blade edge proximally, with smaller serrations distally on basal third, 2–3 per parapodium, 64–81 μm long; about 2 shorter blades below basally spined blades, 48–58 μm long, with edges similar to those of upper blades; lower blades 24–34 μm long, finely serrate

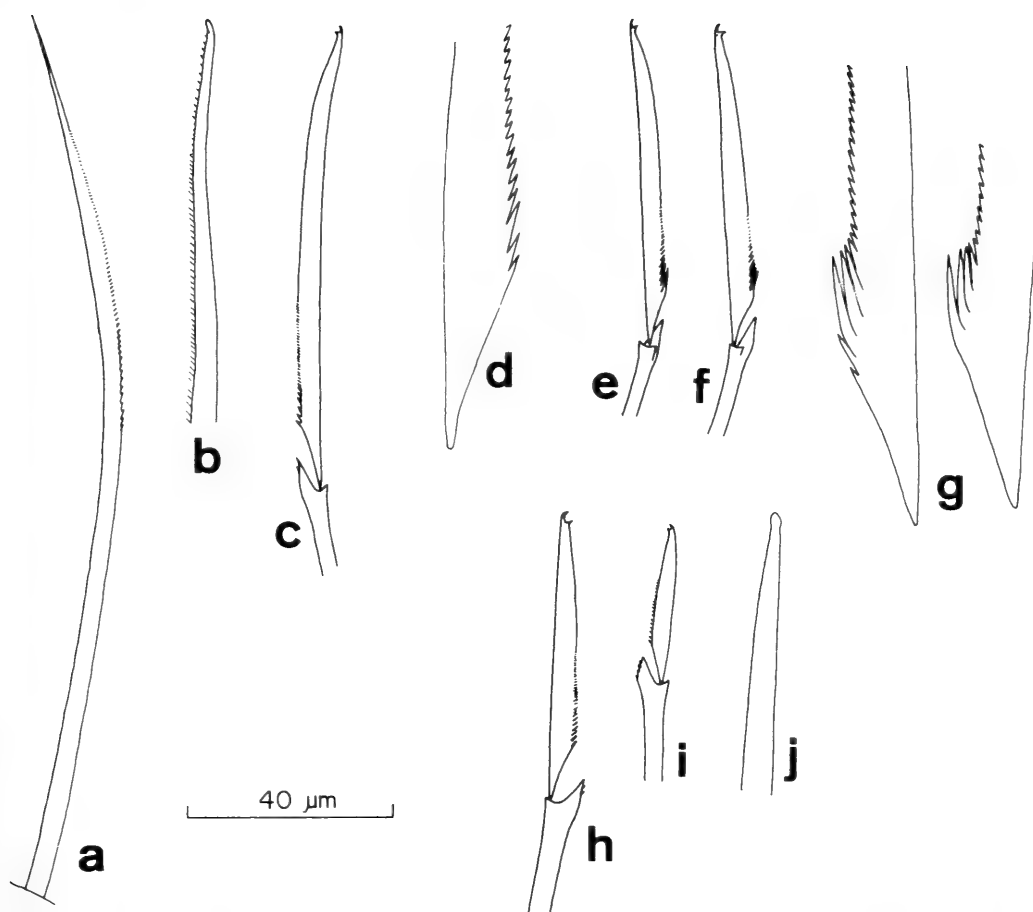


Fig. 32. *Syllides floridanus*: a, Superior simple seta, setiger 10; b, Tip of same (magnified); c, Upper compound seta, setiger 10; d, Base of blade of same, setiger 30; e, Upper middle compound seta, setiger 10; f, Same, setiger 20; g, Bases of blades of same, setiger 30; h, Lower middle compound seta, setiger 20; i, Lower compound seta of same; j, Aciculum, setiger 10 (b, d and g not scaled).

on edge. Shafts similar throughout; distal ends pointed, weakly to strongly serrate; short parts of hinge wider than width of remainder of shaft. Inferior simple setae absent. Neuroacicula (Fig. 32j) solitary; tips slightly enlarged, blunt. Notoacicula (Fig. 31e, f) slender, beginning at least by setiger 10. Pygidium with all lateral anal cirri lost, with short, slender median cirrus. No sexually mature specimens with natatory setae, ova, or external embryos or internal sexual products observed; all probably first appearing in segments with notoacicula.

Pharynx surrounded by brown glands, with about 10 reduced, soft papillae surrounding anterior end; middorsal tooth absent. Proventriculus in 4–5 segments, barrel-shaped; about 42 transverse rows of muscle cells in dorsal view, also arranged in 2 diagonal planes.

*Remarks.*—*Syllides floridanus* is similar to specimens from the northeast



Table 1.—Morphometric characters of *Syllides japonica* from Japan, the northeastern Pacific and New England, *S. j. edentatus* from the Galápagos Islands and *S. floridanus*.

Character	<i>S. japonicus</i> Imajima, Japan	<i>S. japonicus</i> Banse, Northeast Pacific	<i>S. japonicus</i> Banse, New England	<i>S. japonica</i> <i>edentata</i> Westheide, Galápagos Islands	<i>S. floridanus</i> n. sp., Hutchinson Island, Florida
Length (mm)	6–7	Incomplete	4	3.3	3.5
Width (without parapodia, mm)	0.36	0.38	0.5	0.3	0.3
No. setigerous segments	42–46	Incomplete	34	32	38
Pharyngeal papillae	Present	Absent	Present	?	Present (reduced)
Pharynx:proventriculus, length ratio	?	1:1.5	1:1.4	?	1:1.5
Proventriculus, width:length ratio	?	1:1.75	1:2.1	?	1:1.6
Muscle cell rows	?	?	50	45–50	42
Maximum number articles (dorsal cirri)	30	?	?	13	20
Natatory setae (notoacacula) from setiger	?	10	10	9	10
Superior simple seta, tip	Blunt	Fine	Recurved, bidentate	Fine	Fine, capitate
Superior simple seta, length ( $\mu$ m)	100	250	150	150	150
Blades of compound setae:					
Dorsalmost, proximal teeth	Long spines	Long spines and stiff hairs	Long spines	Fine hairs	Stiff hairs
Dorsalmost, length ( $\mu$ m)	84	125	150	65	80–100
Ventralmost, length ( $\mu$ m)	34	25–30	30–40?	27	24–34
Ventralmost:dorsalmost length ratio	1:2.5	1:5	1:3.8	1:2.4	1:3
Basally spined, length ( $\mu$ m)	45 (–84)	?	80 (–150)	47	64–81
No. compound setae (setiger number)	7 (2)	20 (4)	17 (4)	15 (ant)	10 (4)
No. compound setae (setiger number)	8 (10)	10 (25)	10 (mid)	10 (13)	9 (21)

Pacific (USNM 45264) and New England (USNM 10080, 33152) referred to *S. japonicus* Imajima, 1966, by Banse (1971:1477, 1478, fig. 5) and to *S. j. dentata* Westheide (1974:81–83, figs. 36e, 37) from the Galápagos Islands. [One of the New England specimens (USNM 10080), from Cape Cod Bay, was originally identified by Verrill as *S. setosus* Verrill (1882:369); the latter may be one of Verrill's types but was not considered to be such by Banse.] *S. japonicus* Imajima from Japan (Imajima, 1966a:112, 114, fig. 36) has a pharynx with a subterminal, middorsal tooth and perhaps should not be a

member of the genus. Banse's specimens and those of *S. j. edentatus* do not have a pharyngeal tooth and appear to be typical members of the genus. Banse's northeast Pacific specimens lack soft papillae surrounding the anterior end of the pharynx, but such papillae are present in New England specimens. The integument of the tentacular segment and first setigerous segment of northeast Pacific specimens is glandular and similar to that of the prostomium, while in New England specimens only the integument of the tentacular segment is similar to that of the prostomium. Eyes are faint in the epitokous specimen and absent in the nonepitokous specimens Banse reported from New England, but well developed on the Pacific specimens. Superior simple setae of New England specimens are sturdy and flattened in the serrated area and have a recurved tip which under interference microscopy is bidentate with lower cusp small; superior simple setae of northeastern Pacific specimens are very thin and finely pointed (Dr. N. W. Riser, personal communication). Superior simple setae of *S. floridanus* are stout at the base and very fine tipped, with tips entire, slightly hooked and capitate or hooded. Additionally, large basal spines of certain blades of compound setae of New England specimens are curved toward the opposite edges of blades, while on *S. floridanus* such are curved parallel to the toothed edges of the blades. Other differences are noted in Table 1. Such differences seem to indicate 5 distinct species in specimens noted above, 4 of which are typical members of *Syllides*. Certainly, *S. j. edentatus* should be elevated to specific rank. I am unable at this time to describe the New England and northeast Pacific specimens.

*Trypanosyllis* Claparède, 1864

*Trypanosyllis coeliaca* Claparède, 1868

Figs. 33, 34

*Trypanosyllis coeliaca* Claparède, 1868:513, 514, pl. 13, fig. 3.—Fauvel, 1923:270, fig. 101f-h.—Cognetti, 1957:27-29, text-fig. 5a, pl. 1, fig. 5.—Hartmann-Schröder, 1977:85, figs. 23, 24.

*Material examined*.—FLORIDA: Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 7 specimens (USNM 54537; FSBC I 20682-20686). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 9 specimens (FSBC I 20687-20692). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 3 specimens (USNM 54538; FSBC I 20693, 20694).

*Description*.—Body without color markings; eyes dark reddish brown. Flattened, ribbonlike; largest specimen (posteriorly incomplete) 6.0 mm long, 0.65 mm wide across proventriculus, 73 setigers; complete specimen 5.5 mm long, 0.6 mm wide, 79 setigers. Prostomium (Fig. 33a, b) about twice as wide as long; dorsal outline rectangular to trapezoidal; anterior

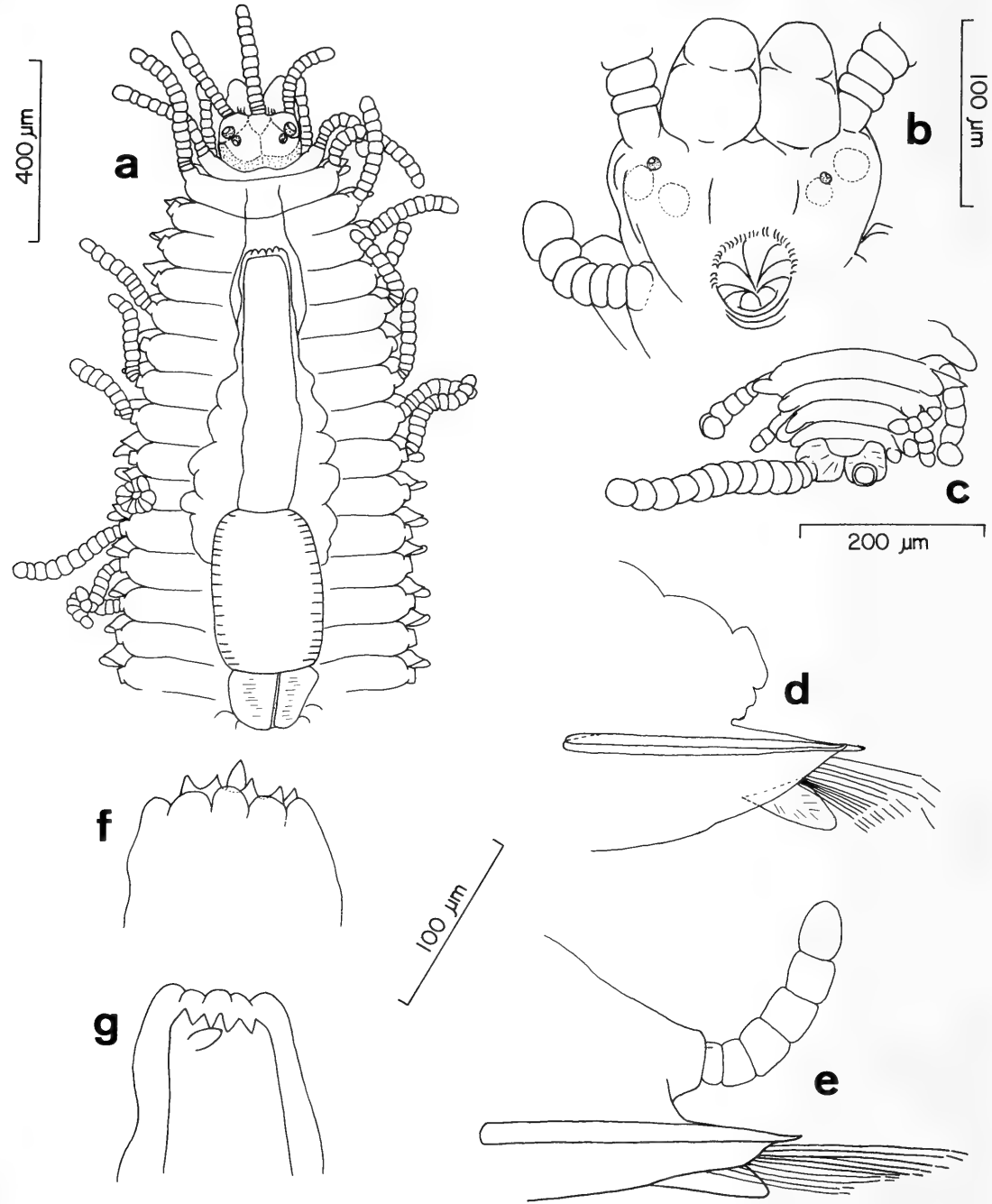


Fig. 33. *Trypanosyllis coeliaca*: a, Anterior end, dorsal view; b, Same, ventral view (FSBC I 20689); c, Posterior end of same, ventral view; d, Parapodium, anterior setiger, anterior view (cirrus missing); e, Same, posterior setiger; f, Anterior border of pharynx, dorsal view (FSBC I 20689); g, Same (USNM 54538).

margin nearly straight, with rounded corners, mostly wider than posterior margin; posterior margin convex, with slight median concavity; 5 lobes dorsally, consisting of 2 triangular, anterolateral lobes, triangular median anterior lobe, and 2 posterior lobes with triangular anterior extensions between

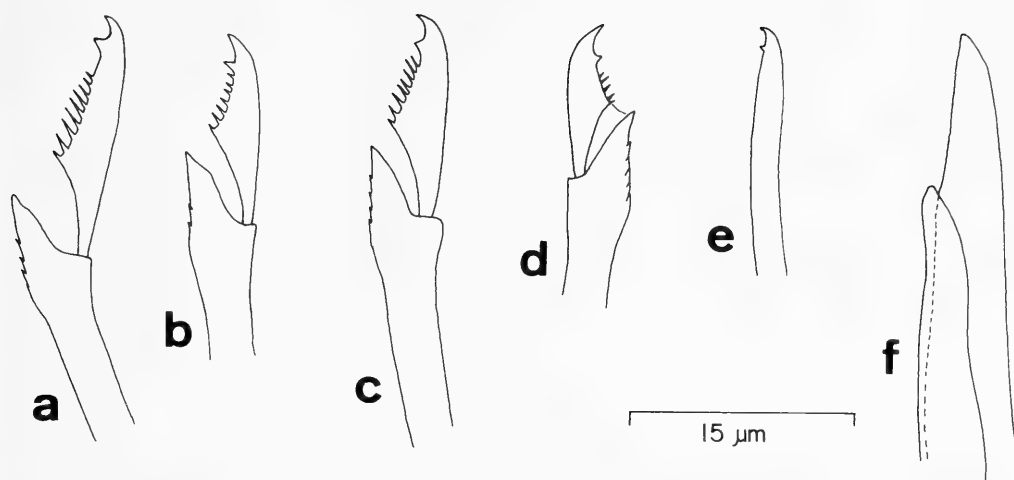


Fig. 34. *Trypanosyllis coeliaca*: a, Upper compound seta, anterior setiger; b, Lower compound seta of same; c, Upper compound seta, posterior setiger; d, Lower compound seta of same; e, Inferior simple seta of same; f, Acicula, anterior setiger.

anterolateral and anteromedial lobes. Lateral antennae and anterolateral pair of dorsal eyes on anterolateral lobes; median antenna originating on anterior margin of anteromedial lobe; posterior pair of dorsal eyes on anterolateral margins of posterior lobes. Ciliated nuchal organs extending across posterior margin of prostomium; ciliated areas also on anterior margin of medial lobe. Dorsal eyes in trapezoidal arrangement open to front, anterolateral pair larger; third pair of eyes on ventral side of prostomium posterior to origin of lateral antennae and palps, generally situated on each side between 2 dorsal pairs. Median antenna with 13 articles, about twice length of prostomium, extending for greater than twice length of palps; lateral antennae slightly shorter, with 10–11 articles, originating ventrally on short ceratophores. Palps originating from anteroventral prostomial margin, shorter than prostomium, appearing superficially articulated, constricted and completely separated at bases in ventral view, ending in round tips, often anteriorly divergent. Tentacular segment dorsally reduced to  $\frac{1}{4}$  length of following segment. Dorsal tentacular cirri originating on short cirrophores, with 10–11 articles, slightly longer than lateral antennae and shorter than dorsal cirri of setiger 1. Ventral tentacular cirri  $\frac{2}{3}$  length of dorsal tentacular cirri, with 7–8 articles. Setigerous segments 7–8 times wider than long. Dorsal cirri with short cirrophores, with 15–16 articles on setiger 1, thereafter with about 10 articles on anterior setigers, long and short in middle segments with about 8 and 12 articles. Parapodial lobes (Fig. 33d, e) flattened, convex posteriorly, more convex anteriorly, with tips acutely pointed, slightly acuminate in dorsal view. Ventral cirri originating below emergence of setae, flattened, with round tips, often extending past tips of setal lobes of anterior segments, shorter posteriorly. Compound setae (Fig.

34a–d) 9–10 in each parapodium; blades bidentate, with relatively long serrations on edge, upper blades longer (18–13  $\mu\text{m}$ ), with more serrations than lower blades on anterior segments, only slightly longer posteriorly (14–12  $\mu\text{m}$ ). Shafts of compound setae with few short serrations subdistally. Solitary, slender, bidentate, inferior simple setae (Fig. 34e) on posterior parapodia. Acicula (Fig. 34f) 2 in each parapodium of anterior setigers, 1 in posterior parapodia; smaller one of anterior parapodia slightly bent near tips; tips of larger acicula stout, emergent, obliquely acute; acicula of posterior setigers similar to larger, anterior ones. Pygidium (Fig. 33c) composed of 3 lobes, posteriorly divided; anal cirri long, stout, with 12–13 articles. Sexual reproduction by stolons; stolons formed by posterior budding; one with dorsal and ventral pairs of eyes, 27 setigerous segments long.

Pharynx (Fig. 33a, f, g) relatively wide, long, in setigers 2–9 or 3–10, slightly more than  $1\frac{1}{2}$  times length of proventriculus; trepan consisting of 10 small, acutely pointed teeth and larger, middorsal tooth; anterior end surrounded by 10 prominent, soft lobes; posterior part surrounded by light brown glands. Proventriculus (Fig. 33a) short, thick, opaque in transmitted light in glycerin, in about 4 segments; length to width ratio 3:2; about 20 transverse rows of muscle cells also arranged in 2 opposite, diagonal arcs; rows of muscle cells not obviously divided by median line. Ventricle occupying about 2 segments, medially divided.

*Remarks.*—Hutchinson Island specimens are in agreement with the original description and other European descriptions of *T. coeliaca*. The pharynx of Hutchinson Island specimens appears similar to that described for *T. fertilis* Verrill (1900:616, 617) from Bermuda, but many other characters are not in agreement.

*Trypanosyllis coeliaca* was described from the Gulf of Naples. It was previously known from the Mediterranean Sea, the eastern North Atlantic and adjacent seas (Hartmann-Schröder, 1977), Florida (Rullier, 1974), and the Solomon Islands (Gibbs, 1971). Gibbs (1971:142) gave no description for the single specimen he reported, and I have not examined it. Rullier (1974:29, 30) reported 2 very young individuals, 2 mm long with 20 setigers, and I cannot confirm from his short description that Hutchinson Island specimens are the same species as the specimens he reported.

*Trypanosyllis inglei*, new species

Fig. 35

*Material examined.*—FLORIDA: Hutchinson Island Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Sep. 1972; USNM 60223); 12 paratypes (USNM 60224; AHF Poly 1323; ZMH P-16405; FSBC I 23664–23672). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 13 paratypes (USNM 60225; AHF Poly 1324;

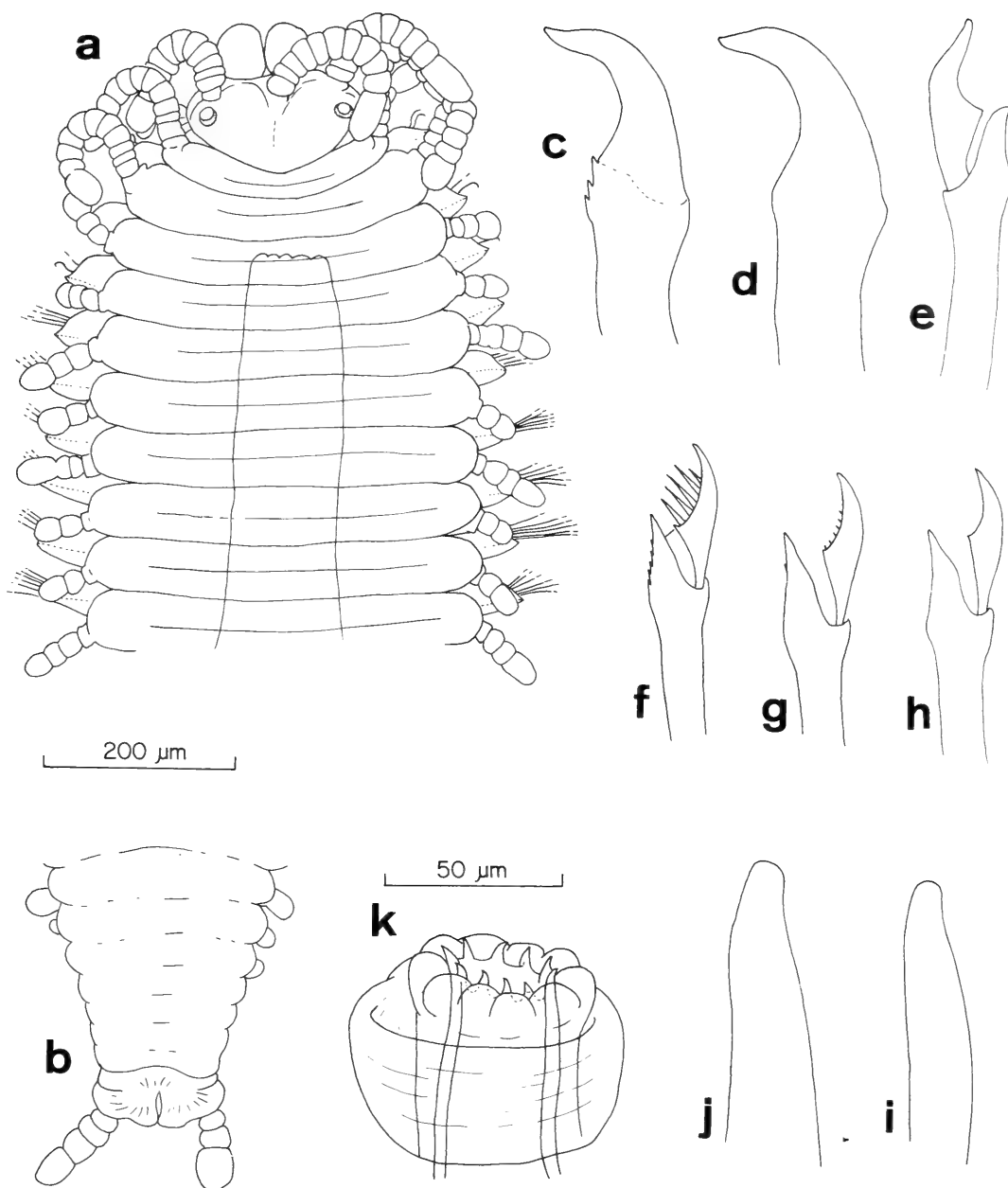


Fig. 35. *Trypanosyllis inglei*: **a**, Anterior end, dorsal view; **b**, Posterior end, dorsal view; **c–e**, Setae, setigers 1–4: **c**, Incompletely fused hook; **d**, Completely fused hook; **e**, Stout compound seta; **f–h**, Compound setae, setiger 8: **f**, Upper; **g**, Middle; **h**, Lower; **i**, Aciculum, anterior setiger; **j**, Same, posterior setiger; **k**, Anterior border of pharynx, ventral view (**c–j** not scaled).

ZMH P-16406; FSBC I 23673–23680). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 2 paratypes (FSBC I 23681, 23682).

**Description.**—Without color markings. Maximum length 8.5 mm, width across proventriculus 0.6 mm, 100 segments; flattened, ribbonlike. Prostomium (Fig. 35a) generally bilobed, about twice as wide as long, reniform,

posterior margin convex, lateral margins rounded, anterior margin straight or concave. Single pair of lensed eyes near anterior margin at about middle of each side. Median and lateral antennae originating near anterior margin on short ceratophores, with about 11 articles; lateral antennae originating above lateral edges of palps; distal articles longer. Palps shorter than mid-prostomial length, together occupying about half total width of anterior prostomial margin, completely separated basally, short, oval in outline. Tentacular segment distinct dorsally, about half length of following segments, appearing biannulate; dorsal tentacular cirri similar to antennae; ventral tentacular cirri about half length of dorsal tentacular cirri, with about 8 articles. Width of setigerous segments 5–7 times length, appearing biannulate; integument very thick. Dorsal cirri of setiger 1 similar to antennae and dorsal tentacular cirri; short on setigers 2 and 3, with 2–3 articles; longer on setigers 4 and 6, with 3–4 articles; short on setigers 5, 7, and 8, with 1–2 articles; alternately long and short thereafter, with 2 and 4 articles anteriorly and 1 and 2 articles posteriorly; all originating on short, distinct cirrophores. Setigerous lobes flattened, acutely pointed, more convex on anterior border than posterior. Ventral cirri of anterior parapodia small, oval, flattened, constricted at base, originating near tips of parapodial lobes on posterior side; broader, longer, originating obliquely on posterior sides with more lateroanterior origins, extending laterally to about tips of parapodial lobes, with nipple-shaped tips on posterior parapodia. Parapodia of setigers 1–4 with about 3 stout, simple, unidentate hooks formed from fusion of blades and shafts of compound setae (Fig. 35c, d) and mostly single, stout, compound setae with unidentate blades (Fig. 35e); hooks as stout as or stouter than acicula; stoutest hook in each parapodium completely fused, other hooks not completely fused. Setae beginning on setiger 5 compound falcigers (Fig. 35f–h) with short, hooked, unidentate blades; dorsal blades with long serrations; ventral blades mostly smooth; blades otherwise similar in size and shape throughout body, length about 10  $\mu$ m. Solitary, inferior simple setae on posterior parapodia, about as stout as shafts of compound setae, slightly curved, unidentate. Acicula (Fig. 35i, j) solitary in all parapodia, stout, with rounded tips, not emergent, confined within acute dorso-posterior lobes. Pygidium (Fig. 35b) composed of 2 flattened, divided lobes, with pair of anal cirri similar to dorsal cirri of midregion, with length of each cirrus not exceeding total width of pygidium.

Pharynx (Fig. 35k) long, slender, often somewhat bent from contraction during fixation, normally in setigers 4–13 when inverted; trepan with 10 widely spaced, acute teeth; 10 soft, rounded lobes encircling distal end. Proventriculus long, narrow, usually in setigers 13–21 (about 9 segments), maximum length 1.0 mm, width 0.16 mm, with 50–57 irregular transverse rows of muscle cells.

*Remarks.*—*Trypanosyllis inglei* cannot be assigned to the subgenera

erected by Imajima and Hartman (1964) since both compound setae and simple setae formed from fusion of shafts and blades of compound setae are present; I know of no described species having both compound unidentate setae and simple setae of this type. However, the species appears to be more aligned with the subgenus *Trypanobia* than with *Trypanosyllis* or *Trypanedenta*, since a middorsal pharyngeal tooth is absent, some simple setae formed from fusion of shafts and blades are present, and blades of compound setae are unidentate.

*Etymology*.—The species is named in honor of Robert M. Ingle, previous Director of the Florida Department of Natural Resources Marine Research Laboratory, who was instrumental in initiating the project in which this species was collected.

*Trypanosyllis parvidentata*, new species

Fig. 36

*Material examined*.—FLORIDA: Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Sep. 1972; USNM 54540). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 2 paratypes (USNM 54541; FSBC I 23683). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 1 paratype (FSBC I 23684).

*Description*.—Body without color markings; eyes dark red. All specimens posteriorly incomplete; largest specimen 10 mm long, width 0.45 mm across proventriculus, gradually widening for anterior half of body, 90 segments, flattened, ribbonlike. Prostomium (Fig. 36a) wider than long; anterior margin straight; lateral margins rounded; posterior margin convex, with median concavity; 5 lobes dorsally including pair of anterolateral lobes, anteromedial lobe, and pair of posterior lobes; ciliated nuchal organ covering posterior width. Eyes 2 pairs, well separated, in trapezoidal arrangement open to front; anterior pair larger, lensed, on anterolateral lobes; posterior pair possibly not lensed, on posterior lobes; ventral eyes apparently absent. Median antenna originating from anteromedial lobe; lateral antennae originating from anterolateral lobes; all on short ceratophores, with 8–10 articles. Palps about as long as prostomial lobe without nuchal organ, narrow at bases, well separated, originating from anteroventral margin, bent ventrally in specimen figured (Fig. 36a). Tentacular segment relatively short dorsally; dorsal tentacular cirri originating on short cirrophores, similar to antennae; ventral tentacular cirri about half as long as dorsal, with about 5 articles. Anterior setigerous segments about 6 times wider than long. Dorsal cirri originating on short cirrophores, with about 15 articles on setiger 1, 10–13 articles on setiger 2, with about 10 articles on following few anterior setigers; dorsal cirri beginning at about setiger 5, alternately long and short, with 15



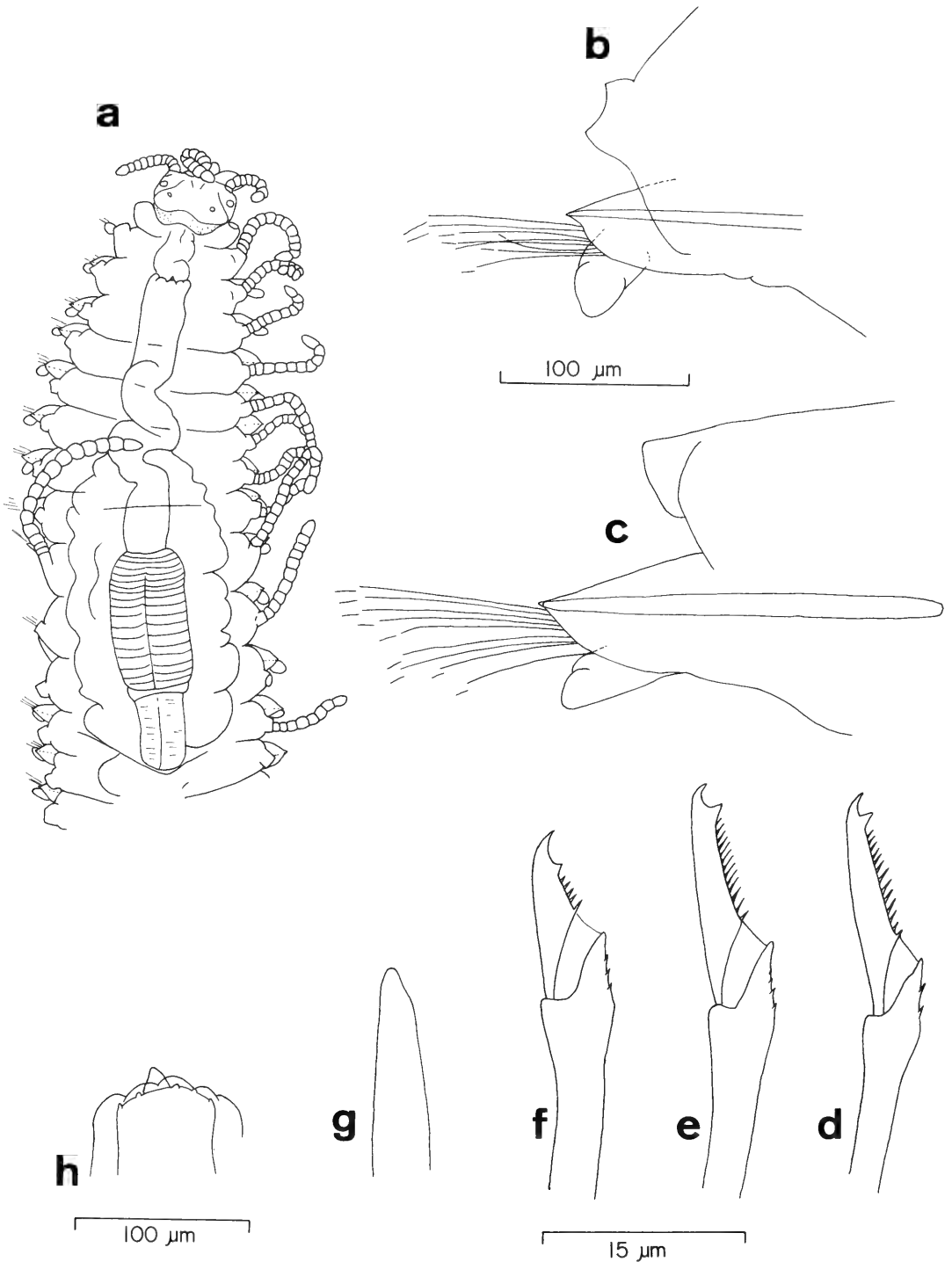


Fig. 36. *Trypanosyllis parvidentata*: a, Anterior end, dorsal view [composite figure of holotype and paratype (FSBC I 23684)]; b, Parapodium, anterior setiger, somewhat oblique anterior view (cirrus missing); c, Same, posterior setiger; d, Upper compound seta, anterior setiger; e, Same, posterior setiger; f, Lower compound seta of same; g, Aciculum, anterior setiger; h, Anterior border of pharynx of holotype, dorsal view.

and 10 articles. Parapodial lobes (Fig. 36b, c) flattened, convex anteriorly and posteriorly; tips acuminate. Ventral cirri originating from near tips of parapodial lobes, stout, superficially appearing articulate, with somewhat ventrally pointing apices. Compound setae (Fig. 36d–f) 8–9 in each parapodium; blades falcigerous, bidentate, similar in anterior and posterior segments but possibly more strongly hooked and with primary and secondary teeth more widely separated in posterior segments, about 16  $\mu\text{m}$  long dorsally, about 11  $\mu\text{m}$  long ventrally; edges with numerous fine serrations from bases to secondary teeth; shafts serrate subdistally. Inferior simple setae not observed. Acicula (Fig. 36g) solitary in all parapodia, with slightly beveled, rounded tips, stouter in posterior segments. Pygidium not observed.

Pharynx (Fig. 36a, h) occupying length of setigers 2–8 or 3–9, often strongly bent from contraction, with thin walls; trepan with 10 very small, obscure teeth and large middorsal tooth; 10 soft lobes surrounding anterior end. Proventriculus (Fig. 36a) 3–4 segments long (setigers 9–11 to 12–13), about twice longer than wide (150  $\mu\text{m} \times 290 \mu\text{m}$ , 170  $\mu\text{m} \times 340 \mu\text{m}$ ), with 18 transverse, medially divided muscle cell rows; ventricle about 2 segments long, also medially divided.

*Remarks.*—*Trypanosyllis parvidentata* differs from other members of the genus in having a trepan of 10 minute teeth in addition to a large, middorsal tooth. Additionally, the species differs from other *Trypanosyllis* species reported herein in the length and number of articles of antennae and cirri, and the fine detail of the compound setae.

*Etymology.*—The species name is derived from Latin and refers to the minute teeth on the trepan.

*Trypanosyllis savagei*, new species

Fig. 37

*Material examined.*—FLORIDA: Hutchinson Island Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; holotype (R. Gallagher, col., Nov. 1971; USNM 60461), 2 paratypes (FSBC I 23685). Sta. V, 27°22.9'N, 80°13.9'W, about 11 m, coarse calcareous sand; 4 paratypes (USNM 60462–60464; FSBC I 23686).

*Description.*—Body without color markings; eyes light reddish orange. Length less than 5 mm; width 0.4 mm at proventriculus; flattened, ribbon-like, maximum 80 segments. Prostomium (Fig. 37a) oval in outline, wider than long, with concave posterior indentation; 5 lobes dorsally including small, anteromedial lobe, pair of small, anterolateral lobes, and pair of large, posterolateral lobes; latter with acute extensions between anteromedial and anterolateral lobes. Two pairs of dorsal eyes close together on opposite sides of midline; anterior pair slightly more widely separated, possibly situated on anterolateral lobes and covered by posterolateral lobes; both dorsal

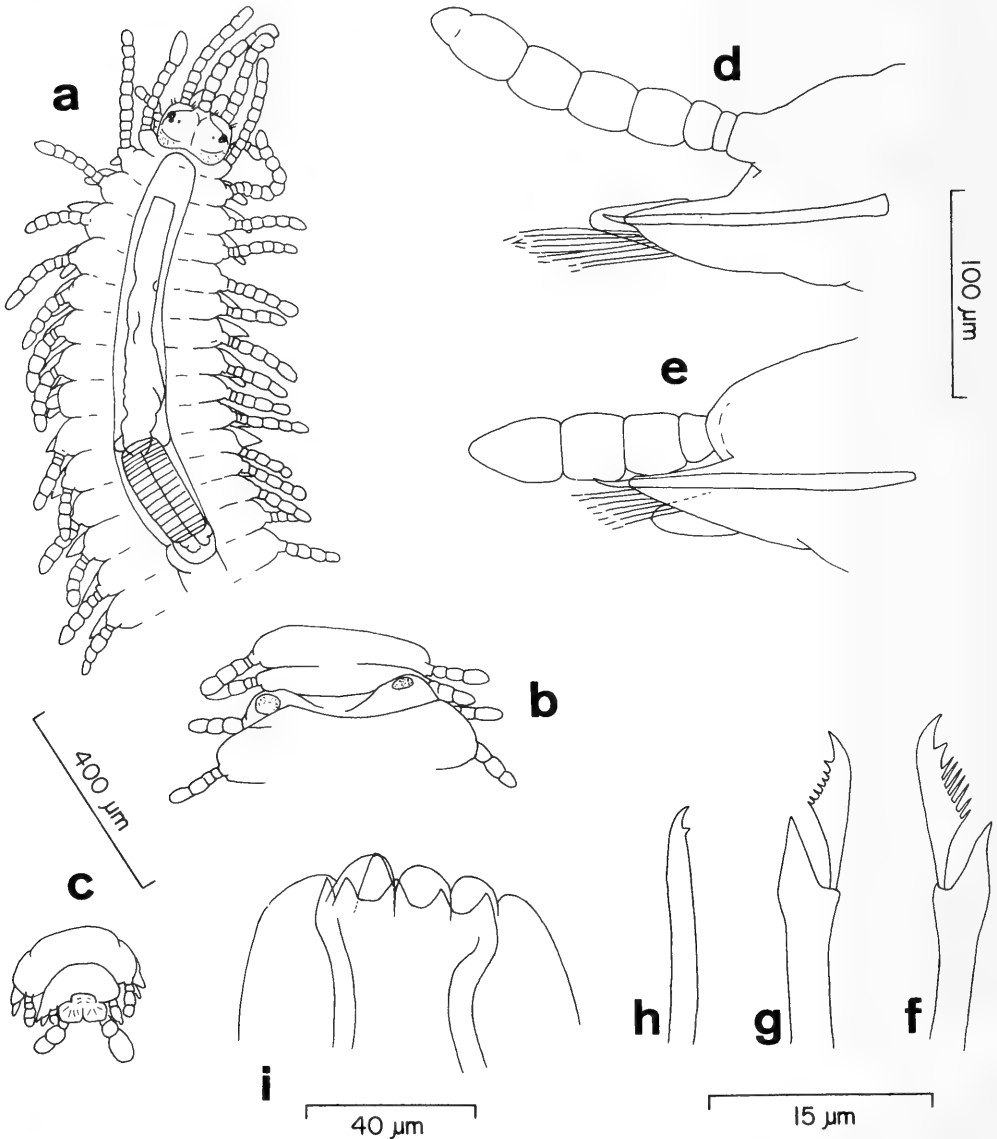


Fig. 37. *Trypanosyllis savagei*: a, Anterior end, dorsal view; b, Middle segments, including anterior end of developing reproductive stolon, dorsal view; c, Posterior end, dorsal view; d, Anterior parapodium, slightly oblique anterior view; e, Same, posterior parapodium; f, Upper compound seta, anterior setiger; g, Compound seta, posterior setiger; h, Inferior simple seta, posterior setiger; i, Anterior border of pharynx, dorsal view.

pairs near lateral margins; smaller, ventral pair of eyes slightly medial to 2 dorsal pairs. Median antenna originating from raised anteromedial lobe, with about 8 articles; lateral antennae originating on anterior margin on short ceratophores, extending for about same distance and similar to median; distal articles about 2 times longer than others. Palps small, about equal in length to half prostomial length, completely separated at bases. Ciliated nuchal organs on posterior margin of prostomium and tufts of cilia on an-

terior margin. Tentacular segment dorsally distinct but reduced to less than half length of following segment, laterally surrounding posterior half of prostomium. Tentacular cirri originating on short cirrophores; dorsal tentacular cirri similar to antennae; ventral tentacular cirri more slender, about half as long as dorsal, with about 6 articles. Mouth opening on ventral posterior border of prostomial lobe. Dorsal cirri of setiger 1 similar to dorsal tentacular cirri and antennae; length equal to about half body width, with 5–6 articles on other anterior segments, with 3–4 or fewer articles on segments behind proventriculus; all originating on distinct, short cirrophores. Parapodial lobes (Fig. 37d, e) flattened; tips usually acutely pointed; anterior and posterior borders convex; posterior borders more convex than anterior ones. Ventral cirri originating from about middle of ventral margins of parapodial lobes about half distance from bases to tips, projecting laterally for about same distance or for slightly greater distance than parapodial lobes; cirri stout, pyriform in outline; tips rounded. Blades of all compound setae similar (Fig. 37f, g), about 12  $\mu\text{m}$  long, slender, falcigerous and bidentate, with primary tooth more prominent than secondary; blade edges pectinate to secondary tooth, with longer serrations on upper blades. Shafts smooth. Solitary, inferior simple setae on posterior parapodia, slender, curved, bidentate. Acicula solitary, stout, acute, often emergent. Pygidium (Fig. 37c) composed of 2 flattened posterior lobes and median, anterior lobe, with pair of anal cirri originating from outer posterior corners on ventral side; each cirrus with about 3 articles. Sexual reproduction by stolons formed by posterior budding; stolon beginning on setiger 45 in specimen figured (Fig. 37b), containing sexual products in all but last few segments.

Pharynx long, narrow, mostly in setigers 2–9; trepan of 10 almost equitriangular, small teeth and larger middorsal tooth; anterior margin surrounded by 10 soft lobes (Fig. 37i). Proventriculus (Fig. 37a) slightly greater than half pharyngeal length, cylindrical, greater than twice longer than wide (220  $\mu\text{m}$  long, 90  $\mu\text{m}$  wide), occupying 3–4 segments (setigers 10–14), with about 17 medially divided, transverse rows of muscle cells. Ventricle in figured specimen convoluted, medially divided.

*Remarks.*—*Trypanosyllis savagei* is similar to specimens of *T. coeliaca* Claparède from Hutchinson Island but differs in several important characters. Although mature specimens of both species have about the same number of segments, *T. savagei* is much smaller and slenderer, and characters such as number of setae per parapodium, number of articles on antennae and cirri, and number of acicula in anterior parapodia are reduced as compared with *T. coeliaca*. The principal difference between the two species is in the shape and character of the proventriculus. The proventriculus of *T. coeliaca* is very stout and opaque in glycerin with transmitted light (see Cognetti, 1957:pl. 1, fig. 5), while the proventriculus of *T. savagei* is slender (greater than 2 times longer than wide) and translucent in glycerin.

*Etymology*.—The species is named in honor of Thomas Savage, formerly of the Florida Department of Natural Resources Marine Research Laboratory.

*Dentatisyllis*, new genus

*Type-species*.—*Syllis carolinae* Day, 1973.

*Diagnosis*.—Body long, cylindrical, with numerous segments. Prostomium with 3 antennae; tentacular segment with 2 pairs of cirri, all articulated. Palps free at base. Eversible pharynx with trepan of 10 teeth and large middorsal tooth; anterior margin surrounded by 10 soft lobes. Nuchal organs absent. Dorsal cirri articulate; parapodial lobes conical; ventral cirri present. Setae compound falcigers joined by superior and inferior simple setae on posterior segments.

*Remarks*.—*Dentatisyllis* has the same relationship to *Typosyllis* Langerhans, 1879, as *Geminosyllis* Imajima, 1966, has to *Haplosyllis* Langerhans, 1879. Both *Typosyllis* and *Dentatisyllis* have numerous cylindrical segments with conical parapodial lobes, and similar antennae, cirri, palps and setae. *Dentatisyllis* differs from *Typosyllis* in having an eversion pharynx with several teeth on the margin while the latter has a pharynx with a smooth anterior margin. *Dentatisyllis* differs from *Trypanosyllis* Claparède, 1864, in that the latter has numerous flattened segments and flattened parapodial lobes.

*Etymology*.—The generic name is formed from the Latin *dentata*, meaning toothed, and the stem generic name, *Syllis*. Gender: feminine.

*Dentatisyllis carolinae*, new combination

Fig. 38

*Syllis* (*Typosyllis*) *regulata carolinae* Day, 1973:30, fig. 4a–f.—Gardiner, 1976:141, fig. 12x–z, 13a.

*Material examined*.—NORTH CAROLINA: off Beaufort, 34°34'N, 76°25'W, 20 m, sand and broken shell; J. H. Day, col., 19 May 1965; holotype (USNM 43146), 4 paratypes (USNM 43147). SOUTH CAROLINA: 32°13'00"N, 79°52'02"W, 24 m, 17 Feb. 1977; 1 specimen (VIMS). GEORGIA: 31°11'59"N, 81°08'00"W, 11 m; R. Bertelsen, col.; 1 specimen (USNM 60472). FLORIDA: Hutchinson Island Sta. I, 27°21.3'N, 80°14.1'W, about 8 m, very fine to fine quartose sand; 1 specimen (FSBC I 20695). Sta. II, 27°21.6'N, 80°13.2'W, about 11 m, coarse calcareous sand; 90 specimens (USNM 54535; FSBC I 4543, 20696–20729). Sta. III, 27°22.0'N, 80°12.4'W, about 7 m, medium calcareous sand; 2 specimens (FSBC I 20731, 20732). Sta. IV, 27°20.7'N, 80°12.8'W, about 11 m, coarse calcareous sand; 134 specimens (FSBC I 20733–20767). Sta. V, 27°22.9'N, 80°13.9'W, about 11

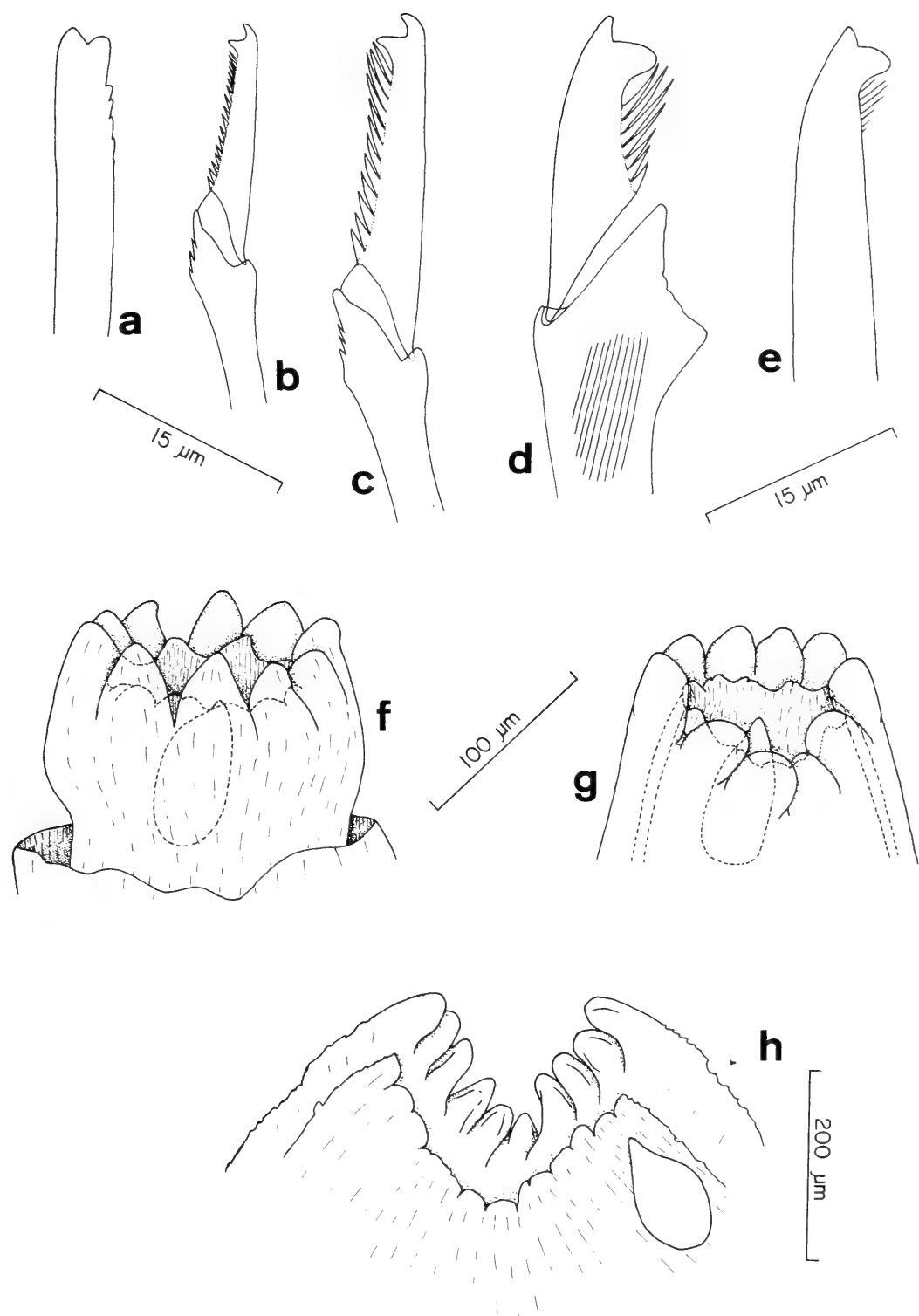


Fig. 38. *Dentatisyllis carolinae*: **a–e**, Setae, posterior setigers (FSBC I 20779): **a**, Superior simple; **b**, Small, upper compound; **c**, Large, upper compound; **d**, Lower compound; **e**, Inferior simple; **f–h**, Anterior border of pharynx: **f**, Paratype, lateral view, everted; **g**, Small specimen, ventral view (FSBC I 20767); **h**, Large, mature specimen (USNM 60474).

m, coarse calcareous sand; 85 specimens (USNM 54534, 60473, 60474; VIMS; FSBC I 20768–20783, 20785–20794). Johns Pass, Tampa Bay area, Pinellas County; B. Howton and R. Dalton, cols., 12 July 1978; 1 specimen (FSBC I 20840). Northeastern Gulf of Mexico, 29°20'00.4"N, 84°44'02.3"W, 30 m, coarse calcareous sand; U.S. Dept. Interior, Bureau of Land Management Miss.-Ala.-Fla. (MAFLA) Study, Transect IV, Sta. 2423; R/V *Columbus Iselin*, July 1976; 1 specimen (USNM 55831).

*Additional description.*—Body slightly tapered for anterior third, broadest in middle, tapered for most of posterior third. Antennae and dorsal cirri of anterior segments relatively slender; dorsal cirri of middle segments much stouter and longer. Prostomium of juveniles with pair of eyespots near anterior margin in addition to 2 larger pairs. Median antenna with about 35 articles; lateral antennae originating posterior to anterior border on short ceratophores, with about 25 articles. Dorsal tentacular cirri similar to median antenna; ventral tentacular cirri similar to lateral antennae, with about 22 articles. Dorsal cirri of setiger 1 much longer than median antenna, with up to 55 articles; setiger 2 dorsal cirri similar to lateral antennae, with 27 articles; setiger 3 dorsal cirri similar to median antenna; dorsal cirri of setigers 4, 6, and 9 similar to cirri of setiger 1; dorsal cirri with about 30 articles on setigers 5, 7, and 8; thereafter alternately short and long to posterior end, with about 30 articles on short cirri and about 55 articles on long cirri of middle segments. Superior simple setae truncate but distinctly bilobed or bifid, with few serrations on ventral borders (Fig. 38a). Falcigers of anterior setigers numerous, with slender shafts and blades. Upper falcigers of posterior setigers with slender shafts and blades; blades as long as upper ones of anterior parapodia on some mature specimens but mostly shorter and similar in length to lower blades (Fig. 38b, c); lower falcigers of posterior setigers with stout shafts and blades (Fig. 38d). Inferior simple setae with tips similar to tips of blades of lower compound setae of posterior segments, with several stiff hairs below secondary tooth (Fig. 38e). Up to 5 acicula in anterior parapodia, 3 in middle parapodia, reduced to 1–2 in posterior parapodia. Pygidium with short, slender, smooth, ventrally originating anal cirrus in addition to 2 ventrolaterally originating articulated ones.

Pharynx (Fig. 38f–h) longer than proventriculus, thin walled, especially on anterior margin, light brown, usually located in setigers 1–2 to 9–11, in 10–11 segments when inverted, with trepan of 10, somewhat irregular teeth on anterior chitinous margin and large middorsal tooth near anterior margin with tip not extending to trepan; anterior end surrounded by 10 soft lobes in apposition to teeth of trepan. Proventriculus usually located in setigers 10–12 to 14–17, in 5–8 segments when pharynx not everted, subcylindrical; length:width ratios 3:1 to 5:1.

*Remarks.*—Compound setae of *D. carolinae* are remarkably similar to those of *Typosyllis regulata* Imajima, 1966, from Japan; antennae and cirri

are similar but shorter on *T. regulata*. However, the anterior border of the pharynx of *T. regulata* is smooth (Imajima, 1966b:290, fig. 64b). Therefore, the 2 species cannot be placed in the same genus, and *D. carolinae* is certainly not a subspecies of *T. regulata* as it was originally described (Day, 1973).

The length and number of articles of antennae and cirri described herein appear to be typical for syllid species with long, articulated dorsal cirri of alternate lengths. The arrangement may become obscured when antennae or cirri have been broken off and are regenerating, resulting in their being shorter, with fewer articles. Small specimens of the species also have antennae and cirri with fewer articles.

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***BARBIDRILUS PAUCISETUS*, NEW GENUS,  
NEW SPECIES (OLIGOCHAETA: ENCHYTRAEIDAE),  
FROM EASTERN NORTH AMERICA**

Michael S. Loden and Steven M. Locy

*Abstract.*—*Barbidrilus paucisetus*, a new genus and species of freshwater enchytraeid oligochaete was collected from the Apalachicola River, Florida. Specimens identical in setal morphology and placement have been collected from North Carolina and Ohio. The new species is unusual in that the setae are present only in the ventral setal bundles of segments II and III. Straight, anteriorly directed setae, elongate spermathecal ducts, and compact penial bulbs are characteristic.

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Investigations of North American Enchytraeidae have lagged considerably behind the work on this group by specialists in Europe, Asia, and South America. Likely synonyms of several of the species, lost type-specimens, and species transferred to other genera have hindered identifications of terrestrial and freshwater species and resulted in few North American investigators willing to study enchytraeids. Tynen's (1975) checklist of species known to occur in North America has provided a much-needed impetus for additional work on this group of oligochaetes.

We believe this to be the first twentieth-century description of a possibly endemic North American genus.

Although most descriptions of enchytraeid species have been based on living material, the specimens we examined were, unfortunately, received in a preserved state. This was of some disadvantage in distinguishing such structures as the nephridia, but because of the large numbers of specimens received, we were able to observe most of the other taxonomically important features of the specimens. Some of the specimens had been stained with a red dye which facilitated observations of internal structures.

*Barbidrilus*, new genus

*Etymology.*—"barba," L. "beard"; "drilos," "worm"; in reference to the anterior ventral placement of elongate setae.

*Diagnosis.*—Setae long, straight, without nodulus, restricted to anterior ventral bundles. Head pore at 0/I. Sorsal pores absent. Esophageal-intestinal transition gradual, no esophageal or intestinal diverticula. Dorsal vessel arising anterior to clitellum. Three pairs of primary septal glands; secondary septal glands absent. Sperm sac present. Sperm ducts long, narrow; penial

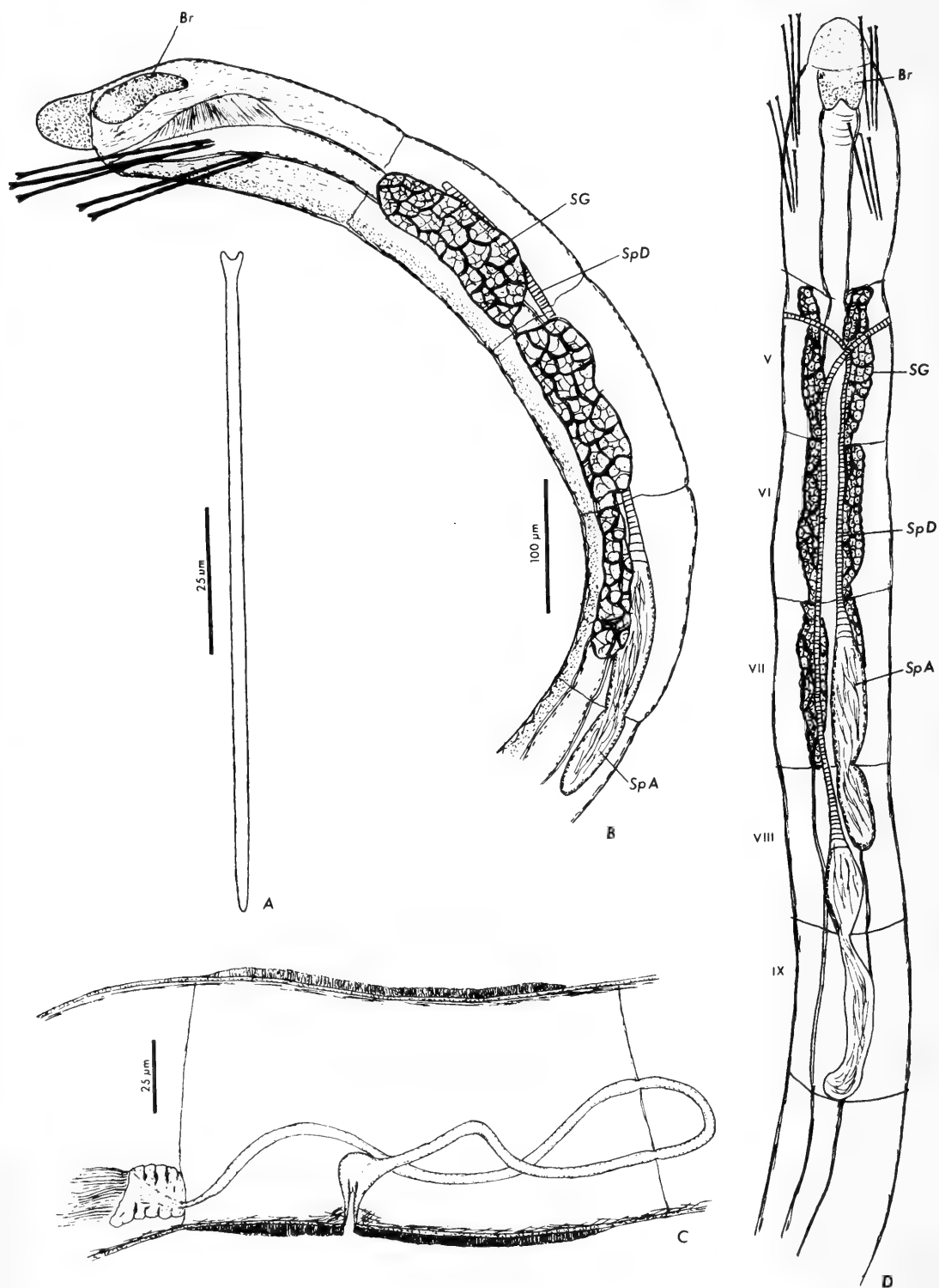


Fig. 1. *Barbidrilus paucisetus*. A, seta; B, lateral aspect of anterior end; C, male duct; D, semidiagrammatic dorsal aspect of anterior end. Br, brain; SG, septal gland; SpA, spermathecal ampulla; SpD, spermathecal duct.

bulbs compact. Ovisac present. Spermathecal ampullae sac-like, not communicating with esophagus; duct long, without associated glands.

*Type-species*.—The following new species:

*Barbidrilus paucisetus*, new species

Fig. 1

*Etymology*.—"paucus," L. "few"; referring to the reduction in setal number.

*Holotype*.—NMNH 60006. Florida: Apalachicola River. River Mile 87.5. 15 December 1978. B. Pruitt, Jr.

*Paratypes*.—Same location and date, 10 specimens (NMNH 60007–60016). Florida: Apalachicola River, River Mile 67.6, 14 December 1978, B. Pruitt, Jr., 9 specimens (LSU 3070).

*Description*.—Length 5–9 mm; width 0.08–0.14 mm. Up to 50 segments. Prostomium rounded, conical, as long as width at peristomial junction. Head pore indistinct, at 0/I; dorsal pores absent. Setae 2–3 per bundle, only in ventral bundles of II and III. Setae long, straight, without nodulus, directed anteroventrally; tips with rounded bifurcations. Setal follicles absent from other segments. Brain as long as wide, incised posteriorly. Esophageal-intestinal transition gradual, no intestinal or esophageal diverticula. Chlorogogue cells sparse, beginning in V. Primary septal glands paired, in V, VI, and VII, varied in pattern, but not united dorsally or ventrally. First 4 segments aseptate. Nephridia present, but characters unobservable in fixed specimens. Peptonephridia present, paired. Clitellum extending XI/XII–XII/XIII with large, closely associated gland cells.

Sperm funnels cylindrical, as long as wide, collar of same diameter as funnel. Sperm duct long, narrow, extending posteriorly as far as XIV. Penial bulb compact, bulbous. Spermathecal pores lateral in V. Spermathecal ducts long, without glands, extending posteriorly to VII or VIII. Spermathecal ampullae thin-walled, sac-like, elongate, free in body cavity, located as far posteriorly as septum IX/X. Spermatozoa in lumen of ampulla, not organized into aggregations.

*Discussion*.—*Barbidrilus paucisetus* is unique among the Oligochaeta in the placement, relative shape, and orientation of the setae.

A reduction in setae such as occurs in *B. paucisetus* is found in two other enchytraeid genera. In *Marionina achaeta* Lasserre, 1964, setae are absent from all segments; in *M. preclitellochaeta* Nielsen and Christensen, 1963, setae are present only in the ventral bundles of segments II through VI. Setae are completely absent in all known species of *Achaeta*.

*Barbidrilus paucisetus* differs from *Marionina* species because of several features. Spermathecae in species of *Marionina* are generally spherical to ovoid; ampullae usually communicate with the esophagus, and the ducts are

mostly confined to segment V with glands associated with either the spermathecal pores or ducts. In *B. paucisetus* the spermathecal ampullae are elongate, sac-like, and free from the gut. There are no gland cells associated with either the ducts or the spermathecal pores, and the spermathecae may extend posteriorly to segment IX.

It is perhaps to species of *Achaeta* that *B. paucisetus* is most closely related. Several species of *Achaeta* (e.g. *A. danica* Nielsen and Christensen, 1959) have elongate spermathecal ducts. The dorsal vessel of all species of *Achaeta* arises in the anteclytellar region, and all lack setae. While most species of *Achaeta* have setal follicles in the position of the missing setal bundles, others (e.g. *A. camerani* (Cognetti, 1889), *A. iridescens* Christoffersen, 1979, *A. littoralis* Lasserre, 1967) share with *B. paucisetus* a lack of them.

Differences between *Achaeta* and *Barbidrilus* include the esophageal-intestinal transition (abrupt in *Achaeta*, gradual in *Barbidrilus*), presence of an ovisac in *Barbidrilus* and an absence in *Achaeta*, location of the head pore (0 in *Achaeta*, 0/I in *Barbidrilus*), and the shape of the penial bulb (subdivided to form gland-like structures in *Achaeta*, compact and pear-shaped in *Barbidrilus*).

*Barbidrilus paucisetus* is known only from freshwater habitats; it has been collected from rivers at locations where fine silt overlies sand. While the type-locality is Florida, specimens with setae that were identical in shape and position to those of *B. paucisetus* have been collected from the South River, North Carolina, and from Sandusky Bay, Ohio.

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THE TADPOLE OF THE COSTA RICAN  
FRINGE-LIMBED TREE-FROG,  
*HYLA FIMBRIMEMBRA*

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*Abstract.*—A single large, long-tailed, tuberculate, and generalized hylid tadpole from the Isla Bonita-Cinchona area of the Cordillera Central of Costa Rica cannot be associated with any of the 93 tadpoles of the family Hylidae described from Mexico and Central America. Consideration of geography and tadpole characteristics typical of the species groups for the 29 hylid species from the region, whose tadpoles are unknown, leads to association of the larva with the fringe-limbed flying frog, *Hyla fimbriembra*. The tadpole is the first to be described for the 5 species of flying frogs that comprise the *miliaria* group.

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In 1963 Norman J. Scott and I collected a single large tadpole from the La Cinchona area of the Cordillera Central of Costa Rica made famous by Edward H. Taylor as the type locality of many amphibians and reptiles (see Savage, 1974). The tadpole was peculiar in the combination of small labial disk, very long tail (77% of total length) and peculiarly tuberculate flanks. The understanding of the characteristics of tadpoles of most Costa Rican anurans was minimal at that time and it was not possible to hazard a guess at our example's identity.

Fortunately, the intervening years have seen the knowledge of larval stages for Costa Rican anurans increase several fold and tadpoles for most species, except the many forms in the genera *Bufo* and *Centrolenella*, are now known. In the course of preparing a review of the tadpoles of Costa Rican frogs and toads, I have again turned to an attempt at associating the Cinchona example (Fig. 1) with a named adult population.

The example in question was collected at Costa Rica: Provincia de Alajuela: Canton Alajuela: Cinchona (1,360 m) by Jay M. Savage and Norman J. Scott on 26 September 1963, between 8:30 and 10:00 P.M. It is number 7015 in the CRE collection at the University of Southern California. Its salient features are summarized below, using the terminology of Duellman (1970:33-43), where applicable.

*General Features.*—Stage 38 (system of Gosner, 1960). Body robust, width somewhat greater than depth. Nostrils directed anteriolaterally, eyes directed laterally. Anus dextral; spiracle sinistral, located on side of body below level of eye, about  $\frac{1}{2}$  of distance from eye to posterior margin of



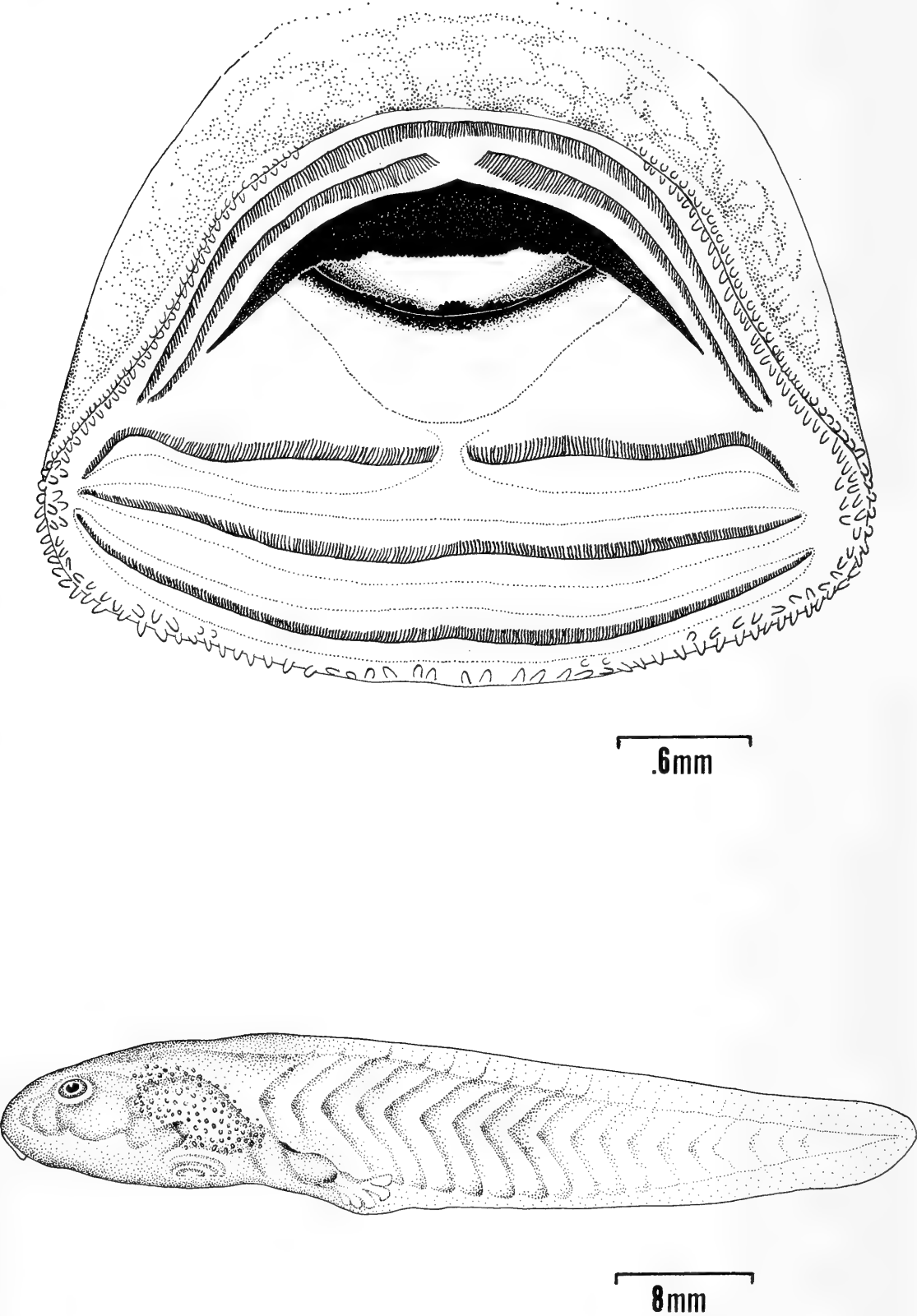


Fig. 1. Tadpole of *Hyla fimbrimembra*. Upper, oral disk; lower, lateral view.

body. Lateral area of posterior portion of body heavily tuberculate. Caudal fin extending onto body as a low ridge that reaches almost to level of spiracle; dorsal portion about  $\frac{1}{3}$  depth of caudal musculature, ventral portion reduced; fin rounded at end.

Oral disk small, anteroventral, directed ventrally. Disk complete, not indented laterally; disk bordered laterally by 2–3 rows of small papillae, below by 1 row; oral papillae incomplete across upper labium. Upper beak a narrow arch, lower beak less well-developed, both with small serrations. Denticles in  $\frac{2}{3}$  rows, row immediately above upper beak interrupted medially, uppermost row and row just below lower beak longest, about equal in length, others only slightly shorter.

*Coloration*.—Dorsum and sides of head uniform brown, gradually grading into dirty white venter; flanks lightly pigmented but appear black because black parietal peritoneum visible through skin. Hindlimb rudiment strongly barred with black above. Tail musculature light pinkish tan; caudal fins and overlying skin transparent with distinct network of mottled black pigment.

*Measurements (mm)*.—Standard length (body length) 17; tail length 57; total length 74; tail length 77% of total length.

### An Attempt at Identification

At the present time Costa Rica has a known anuran fauna of approximately 120 species. Thirty-three of these forms, all members of the genus *Eleutherodactylus*, are either known to have direct development without a tadpole stage or are presumed to share this feature in common, as far as known with all approximately 300 members of the genus. The remaining species are allocated to 8 frog families as follows, with the denominator indicating the number of Costa Rican species in the family, and the numerator the number for which tadpoles have been described: Rhinophrynidae (1/1); Microhylidae (1/3); Leptodactylidae (6/6); Bufonidae (5/14); Hylidae (34/39); Dendrobatidae (5/7); Centrolenidae (7/13); and Ranidae (4/4).

The characteristics of the Cinchona example do not match the description of any known tadpole from Costa Rica or from adjacent areas of Central America. It must therefore represent a known species for which the tadpole is not known or an unknown species. If one follows a process of elimination based on the available data, the number of feasible alternative possibilities can be substantially reduced. In the following comparisons, features for the unnamed tadpole are indicated in parentheses.

There is little likelihood that the mystery tadpole represents an undescribed species of either the Rhinophrynidae or Microhylidae. All known members of these families have tadpoles that lack beaks and denticles and have either two spiracles or a single ventrally located one (beaks and denticles present; a single sinistral spiracle).

Members of the family Ranidae are also excluded from consideration since the tadpoles of all known Central American species have been described and have either the oral disk indented laterally (*Pipiens* group) or high numbers of denticle rows  $3/4$  to  $6/4$  (complete oral disk and denticle rows  $2/3$ ).

The tadpoles of members of the genera *Atelopus* and *Bufo* (family Bufonidae) are distinctive and cannot be confused with the present specimen. *Atelopus* has a well-developed ventral disk (no ventral disk) and *Bufo* has the oral papillae incomplete on upper and lower labia (complete on lower labium).

The Centrolenidae may also be eliminated from consideration since all known tadpoles of this family have a median anus, very short denticle row segments just above the mouth that are separated from one another by a huge gap above the beak and are pale pink to bright red (in life) with minimal dark pigment (dextral anus, only a narrow gap in long denticle row segments just above beak, and with considerable dark pigmentation).

Members of the family Leptodactylidae known from lower Central America that have free-living larvae may also be eliminated from consideration. *Leptodactylus* has a median anus (dextral); *Physalaemus* has the oral disk indented laterally (oral disk complete) and *Pleurodema* has a median anus (dextral).

Members of the family Dendrobatidae show a considerable diversity of larval features (Savage, 1968; Silverstone, 1975, 1976). In known *Phyllobates* and most *Colostethus* the oral disk is indented laterally (oral disk complete). In most *Dendrobates* the anus is median (dextral) but in those with a dextral anus the oral disk is indented (oral disk complete). In the Costa Rican form *Colostethus nubicola* which has a non-indented umbelliform oral disk (complete but non-umbelliform oral disk) the anus is dextral and denticle rows are absent ( $2/3$  denticle rows). The tadpole of *Dendrobates pumilio* of Costa Rica also has a complete oral disk but has a median anus (dextral) and 0– $1/2$ –2 rows of denticles ( $2/3$  rows of denticles).

The mystery tadpole has been compared directly to tadpoles of all lower Central American species for which tadpoles are known in the 7 families discussed above. There can be little doubt that it is distinct from all of them and almost certainly does not represent an undescribed species or any known species for which the tadpole remains unknown at this time. This comparison eliminates from serious consideration as the possible congeners of the tadpole representatives of all the lower Central American genera of these families except for the monotypic bufonid *Crepidophryne*. No tadpole is known for this genus which seems to be a specialized derivative from *Bufo* (Savage and Kluge, 1961). Most likely, if the species has a tadpole stage, it would agree with *Bufo*, which uniformly has the oral disk indented laterally and the oral papillae broadly interrupted across both the upper and

lower labia (oral disk complete; complete series of papillae across lower labia). In addition, *Crepidophryne* is known from only a few localities in the Cordillera de Talamanca (Savage, 1972), the closest some 75 km southeast of the collecting site for the unknown larvae.

The unidentified tadpole agrees in basic features with generalized tadpoles of species in the large family Hylidae, the only family not eliminated from consideration in the above review. These basic features include: complete oral disk, dextral anus, sinistral spiracle located laterally, denticles 2/3, and oral papillae incomplete across upper and complete across lower labium. Among the hylids of lower Central America, 5 members of the genus *Hyla* (*angustilineata*, *elaeochroa*, *loquax*, *pseudopuma* and *staufferi*) and 4 members of the genus *Smilisca* (*baudinii*, *phaeota*, *puma* and *sila*) resemble the Cinchona tadpole in these basic features. Direct comparison of comparable stages of tadpoles of these 9 forms to the unnamed larva clearly indicates that it cannot be associated with any of them. It may most easily be separated from *H. elaeochroa* and *H. staufferi* by the shape of the body and fin form. In the latter 2 species the body is deep, with the depth much greater than width and the tail fins are deep, with upper and lower portions much deeper than tail musculature, and taper to a point (body ovoid, depth and width about equal; depth of upper and lower portions of caudal fin less than depth of tail musculature and tip of fin rounded). *H. loquax*, *S. baudinii* and *S. phaeota* most obviously differ from the Cinchona tadpole in having smooth bodies (tuberculate). *H. angustilineata*, *H. pseudopuma* and *S. sila* do not have the dorsal portion of the fin extending onto the body (fin extending onto body).

The above review indicates that the mystery tadpole represents a species of the tree-frog family Hylidae. An analysis of the characteristics of the larvae of this family from Mexico and Central America, almost all of which are so ably described and illustrated by Duellman (1970), confirms this view. Of 122 hylid species now recognized from the region, the tadpoles of 29 remain undescribed. Most of the species (20) for which tadpole data are lacking occur in the highlands of southern Mexico and Guatemala (15) or are inhabitants (5) of sites in western Mexico (one of these forms reaches Guatemala and El Salvador). All of these species are found at sites far removed geographically and ecologically from the Cordillera Central of Costa Rica.

Of the remaining 9 forms without known tadpoles, all from lower Central America, three species, *Agalychnis calcarifer* and *A. litodryas* and *Phyllomedusa venusta*, belong to genera whose tadpoles are so distinctive as to eliminate them from consideration. Tadpoles for these genera uniformly have the spiracle located ventrally although sinistral to the midventral region and have a pointed tail fin (lateral spiracle and rounded tail fin). One form, *Hyla pugnax* of the Pacific lowlands in western Panama and northern Co-

lombia (Kluge, 1979) belongs to a species group in which all known tadpoles have 2/4 denticle rows.

The elimination of the 4 mentioned species from consideration leaves 4 forms, *Hyla fimbriembra*, *H. lythrodes*, *H. miliaria* and *H. xanthosticta*, all known from Costa Rica, and *H. thysanota*, known only from extreme eastern Panama, as candidates for association with the tadpole. *H. lythrodes* and *xanthosticta*, each known from a single male holotype, are unlikely to be conspecific with the tadpole. All of the allies of these two forms (Savage, 1967; Duellman, 1970) have larvae with oral papillae complete across the upper labium (incomplete). Direct comparison of the Cinchona tadpole with known tadpoles of these 7 allied forms convinces me that they are not related. Additional differences include: *H. rufiocularis* and *uranochroa*, 2/2 denticle rows (2/3); *H. legleri*, 2/5 denticle rows (2/3); *H. rivularis*, *pictipes* and *tica*, 4–7 rows of papillae on lower labium (1); and *H. debilis*, body depressed (ovoid). *H. lythrodes* is most similar to *rufiocularis* and *xanthosticta* to *pictipes* in adult features.

The analysis leaves only the Costa Rica and Panama members of the *Hyla miliaria* group (Duellman, 1970) (*fimbriembra*, *miliaria*, and *Thysanota*) as probable adult representatives of the mystery tadpole. Significantly, the tadpole of no member of this distinctive group of large frogs has ever been described. The group as currently understood contains 5 species: *echinata* of southern Mexico; *fimbriembra* of Costa Rica; *miliaria* of Nicaragua, Costa Rica, Panama and Colombia; *thysanota* of eastern Panama; and *valancifer* of southeastern Mexico and Guatemala. Only the 2 Costa Rican species seem reasonable candidates for association with the Cinchona tadpole.

Of the 2 forms, it is clear that the tadpole almost certainly is *H. fimbriembra*. This species is known from only 2 specimens (Duellman, 1970) an adult female (the holotype) and a juvenile male (the holotype of the name *H. richardtaylori*). Both examples were collected in the Isla Bonita–Cinchona area (Savage, 1974), a few kilometers apart, by Edward H. Taylor (1948). The tadpole subject of this paper was collected virtually at the type locality of *fimbriembra*. *Hyla miliaria*, on the other hand, is known only from one locality, at 600 m elevation in Costa Rica.

Adult members of the *miliaria* group are very large (known to reach 106 mm in male *miliaria*) frogs with immense hands and feet that are extensively webbed. In addition the outer margins of the hands, forearms, and feet have extensive fleshy fringes. Known adult males have the prepollex modified as a projecting spine (*miliaria*), a spadelike plate (*valancifer*), or clump of spines (*echinata*). Duellman (1970) has described and illustrated the use of the hands, feet, webs and fringes in the flight, or more accurately glide, in an example of *miliaria*. All known juveniles of the group have a tuberculate dorsum and the unique and extensively tuberculate body of the tadpole here

associated with *H. fimbrimembra* is another confirmation of the correctness of this allocation. I have seen no other hylid tadpole from Mesoamerica having this condition.

Certainly adults of the *miliaria* stock are among the rarest and most bizarre of New World tree-frogs. The tadpole of *H. fimbrimembra* is quite ordinary and shares basic character combinations with many other hylids. This situation offers support for Starrett's Rule which states that the most specialized and uniquely modified tadpoles develop into ordinary frogs whereas the most bizarre and distinctive frogs have ordinary, generalized tadpoles.

### Acknowledgments

I wish to thank Norman J. Scott, the John Simon Guggenheim Memorial Foundation, and the Organization for Tropical Studies (OTS) for aid in the fieldwork that made this paper possible. Frances Runyan prepared the tadpole drawings and I greatly appreciate her contribution to the effectiveness of the account.

Finally, I wish especially to acknowledge the advice on, and insight into, tadpole biology provided over the past 20 some years by my colleague, the discoverer of Starrett's Rule, Dr. P. H. "Holly" Starrett.

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## COMMON INSHORE BARNACLE CYPRIDS OF THE OREGONIAN FAUNAL PROVINCE (CRUSTACEA: CIRRIPIEDIA)<sup>1</sup>

Jon D. Standing

*Abstract.*—Seven species of barnacle cyprids from field collections are illustrated, described, and compared. Cyprids described in detail are *Pollicipes polymerus*, *Chthamalus dalli*, *Balanus glandula*, *Balanus nubilus*?, and *Semibalanus cariosus*. Previous descriptions of the cyprids of *Balanus crenatus* and *Balanus improvisus* are amplified. Ecological notes and a key to the species are also given.

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The sessile stages of barnacles, their systematics and biology, have received considerable study for more than a century. Yet our knowledge of barnacle larvae has advanced slowly, despite their prominence in inshore waters, and their importance in unifying the four orders of Cirripedia. This situation has prevailed for two main reasons. First, larvae have been regarded historically as mere developmental stages in the life history of the all-important adult. Fortunately, many biologists now view them as functional, independent animals having important ecological roles, and deserving of more detailed study.

Second, barnacle larvae, especially cyprids, have proved difficult to distinguish and to identify (Pyefinch, 1948; Costlow and Bookhout, 1958; Moyse, 1961; Crisp, 1962; Barker, 1976; Lang, 1979). Specimens collected from plankton samples are not easily linked to known adults, and laboratory-reared cyprids frequently differ from their "wild" counterparts in size and shape (Freiberger and Cologer, 1966; Lang, 1979). Workers dealing with only one or two species have usually lacked the comparative material necessary for good descriptions, and most studies on barnacle larvae have focused on the naupliar stages rather than on the cyprids. Thus, illustrations and measurements of cyprids are fairly common in the literature, but full descriptions are rare.

This paper describes seven species of cyprids from the Oregonian Province. These are *Pollicipes polymerus*, *Chthamalus dalli*, *Balanus glandula*, *Balanus crenatus*, *Balanus improvisus*, *Balanus nubilus*?, and *Semibalanus cariosus*. Although some of these species have been illustrated or briefly

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<sup>1</sup> Part of a doctoral dissertation to be submitted to the Department of Zoology, University of California, Berkeley.



described previously, they are included here either because earlier accounts do not compare them to other Oregonian forms, or because this study has revealed characters not observed before. Also included here are notes on identification, distribution, and abundance, and a key to the species.

### Materials and Methods

Unless otherwise noted, cyprids were collected in Bodega Harbor, California, from April 1975 to November 1978. Bodega Harbor is a small, partially closed embayment located about 100 km north-northwest of San Francisco. It has coastal water conditions and considerable tidal exchange. The collection site was the U.S. Coast Guard wharf, near the mouth of the harbor. Of the cyprids examined from Bodega Harbor, 99.93% were referable to the species described here (excepting *Balanus improvisus* and *Semibalanus cariosus*); 0.07% were of uncertain identity.

Samples were taken with a gasoline-driven pump, fitted with an intake hose, and filtered through a 158  $\mu\text{m}$  mesh plankton net. In 1976 and 1977, cyprids were collected at three depths: 30 cm above the bottom (depth 3–5 m, depending on tidal level), 15 cm below the surface, and midway between the surface and bottom. Volumes sampled at each depth were 1.0 m<sup>3</sup>. Samples were collected halfway between the predicted times of lower low water and higher high water levels on flood tides. Sampling frequency was about every eight days. Cyprid densities are based on samples collected from October 1976 to November 1977. Adult distributions are modified from Newman (1979a).

Identification of cyprids was accomplished in several different ways. First, some identifications were based primarily on laboratory rearing: either cyprids were raised from embryos taken from identified adults, or field-collected cyprids were induced to settle and grow into identifiable juveniles. Second, spatial and temporal coincidences of large numbers of cyprids and newly settled juveniles were frequently observed in the field. The cyprids were later identified by following cohorts of juveniles through time until they became identifiable. Third, some cyprids could be identified by comparing them to illustrations or descriptions in the literature, or by comparing them to cyprids identified in other parts of the world. Finally, considerable information on the local and geographical distributions of adults was available. However, caution must be exercised in inferring cyprid identifications from large-scale distributions of adults. Identifications based on several different kinds of evidence are likely to be most reliable.

Cyprids were studied with dissecting and compound microscopes for descriptive characters. Special attention was directed towards taxonomic features not requiring high power microscopy and microdissection. These features were carapace shape, size, and sculpturing, together with special



pigmentation patterns. Shape and size characters were initially observed by carefully aligning the body in side and dorsal views. This alignment was accomplished by sticking the animal to a dish with a tiny dab of silicone grease, and then orienting it so that the body was as horizontal as possible in dorsal view, and so that the compound eyes were superimposed in side view. Size measurements were made with a dissecting microscope fitted with an ocular micrometer and were representative of all cyprids collected in 1977, unless otherwise indicated. The measurements taken were length—from anterior to posterior carapace margins, depth—greatest distance between dorsal and ventral carapace margins, and width (breadth)—greatest distance between one side and the other. Special pigmentation characters, as referred to here, are those that appear to differ from general ground color and from color that may be associated with specific organs. These characters were observed on freshly killed cyprids, as well as formalin-preserved ones, because pigmentation characters sometimes fade in preservatives. Observation of sculpturing characters required the high dry magnification of a compound microscope. The drawings were made with the aid of a camera lucida.

Voucher specimens of the species described here have been placed in the National Museum of Natural History (USNM 181245–181251).

Subclass Cirripedia

Order Thoracica

Suborder Lepadomorpha

Family Scalpellidae

Subfamily Pollicipinae Zevina, 1978

*Pollicipes polymerus* Sowerby, 1833 (= *Mitella polymerus*)

Fig. 1

*Distribution*.—Adults: lower midtidal and low intertidal zones of wave-swept shores; on rocks and hard-shelled animals. Cyprids: throughout water column, mean density 10 m<sup>-3</sup>; mainly in fall and winter. British Columbia south to Cape San Lucas, Baja California.

*Identification*.—(1) Cyprids reared in the laboratory from embryos, using the methods of Lewis (1975). (2) Juveniles and adults present on floating pier adjacent to Bodega Harbor collection site. (3) Cyprid illustrations in Broch (1922) and Lewis (1975), although Lewis's drawing does not resemble *P. polymerus*. Naupliar stages described and figured in Lewis (1975).

*Diagnosis*.—Small, mean length 494  $\mu$ m. Translucent when fresh. Relatively translucent when preserved, with light orange cement glands posteroventral to compound eyes. No special pigmentation. Carapace profile relatively high in side view; anterior end broadly rounded; posterior end narrowly rounded; anterodorsal margin broadly curved; posterodorsal mar-

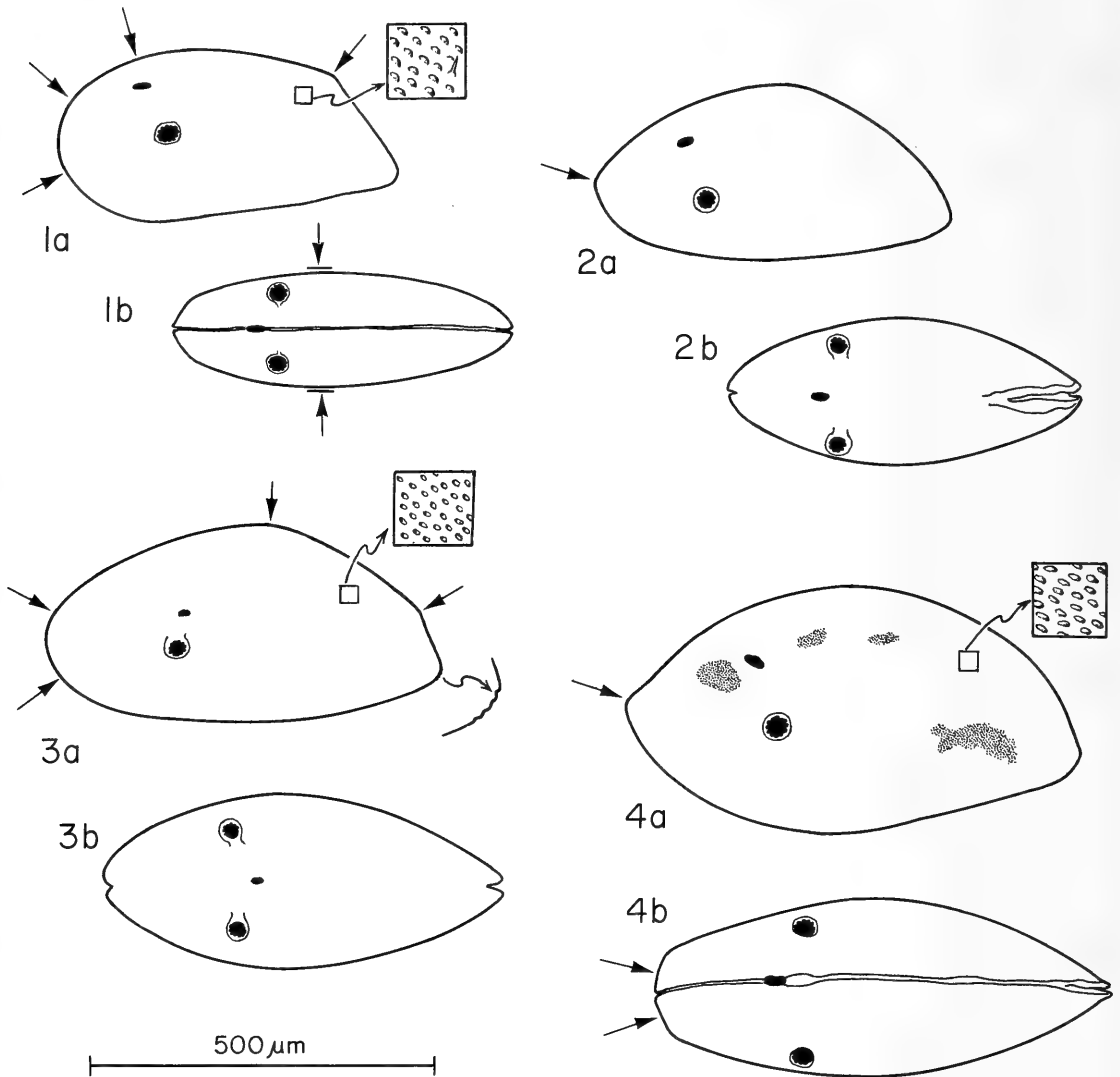
Table 1.—Sizes of barnacle cyprids in  $\mu\text{m}$ . Depth is the measurement between the dorsal and ventral carapace margins; width, the measurement between sides. Data are expressed as means; ranges are given in parentheses.

Species	Collection site	Length	Depth	Width	n
<i>Pollicipes polymerus</i>	Bodega Harbor, California	494 (420–520)	256 (220–260)	177 (160–200)	50
<i>Chthamalus dalli</i>	Bodega Harbor, California	529 (440–580)	270 (240–300)	230 (200–260)	50
<i>Balanus glandula</i>	Bodega Harbor, California	728 (640–780)	388 (320–440)	309 (240–360)	50
<i>Balanus crenatus</i>	Bodega Harbor, California	852 (700–960)	374 (300–440)	328 (260–400)	50
<i>Balanus crenatus</i>	Point Barrow, Alaska	1,001 (900–1,060)	473 (400–520)	450 (380–520)	67
<i>Balanus improvisus</i>	San Francisco Bay, California	584 (540–610)	304 (270–340)	285 (250–320)	25
<i>Balanus nubilus?</i>	Bodega Harbor, California	932 (800–1,000)	431 (360–480)	345 (280–400)	50
<i>Semibalanus cariosus</i>	San Juan Island, Washington	1,111 (960–1,200)	499 (420–560)	493 (440–560)	21

gin curved, breaking about two-thirds of the way towards posterior end; ventral margin broadly curved anterior to, and relatively straight posterior to, compound eyes. Carapace profile narrowly fusiform in dorsal view, mean width 177  $\mu\text{m}$ ; both ends broadly rounded. Entire carapace sculptured with uniform, rounded, regularly-spaced papillae (about 4.5  $\mu\text{m}$  in diameter and 1.5  $\mu\text{m}$  high) and occasional spine-like processes (about 7  $\mu\text{m}$  high).

*Size variation*.—Mean length 494  $\mu\text{m}$ , range 420 to 520  $\mu\text{m}$  at Bodega Harbor, California (Table 1).

*Remarks*.—This cyprid is the smallest one discussed here, although its size overlaps broadly with that of *Chthamalus dalli*. It differs from the cyprids of *C. dalli*, *Balanus improvisus*, and most other species in having a broadly rounded anterior end in side view, a break in the posterodorsal margin, a narrow carapace profile in dorsal view, and a carapace sculptured with small papillae. The greatest depth of the carapace is at about the level of the compound eyes, rather than considerably behind this level as in the other species. The cyprid of *P. polymerus* is similar to the somewhat larger cyprid of *B. improvisus* in having a break in the posterodorsal margin, but differs in having the carapace sculptured with papillae rather than pits. The latter two species are also spatially separated, co-occurring mainly around the mouths of some enclosed bays.



Figs. 1–4. Lateral (a) and dorsal (b) views of barnacle cyprids. 1, *Pollicipes polymerus*; 2, *Chthamalus dalli*; 3, *Balanus improvisus*; 4, *Balanus glandula*. Insets show carapace sculpturing; pigmented areas are stippled. Straight arrows indicate some diagnostic characters used in the key.

Suborder Balanomorpha  
 Superfamily Chthamaloidea  
 Family Chthamalidae  
 Subfamily Chthamalinae  
*Chthamalus dalli* Pilsbry, 1916

Fig. 2

*Distribution*.—Adults: intertidal zone of exposed and protected shores; on rocks, pier pilings, and hard-shelled animals. Cyprids: surface and mid-depths mainly, mean density 11  $\text{m}^{-3}$ ; mainly in summer and fall. Northern Japan and Alaska south to San Diego, California.

*Identification*.—(1) Juveniles reared in the laboratory from field-collected cyprids. (2) Adults present on pilings adjacent to collection site. Naupliar stages have not been described or figured.

*Diagnosis*.—Small, mean length 529  $\mu\text{m}$ . Translucent when fresh, with paired, dark areas located about halfway between compound eyes and posterior end. Relatively translucent when preserved, but more opaque anteriorly; with prominent light brown cement glands posteroventral to compound eyes. No special pigmentation. Carapace profile relatively high in side view and peaked dorsally at midlength; anterior end narrowly rounded to angular; posterior end narrowly rounded; anterodorsal margin slightly curved; posterodorsal margin evenly curved; ventral margin curved anterior to, and slightly curved posterior to, the compound eyes. Carapace profile in dorsal view broadly fusiform, with both ends rounded. Carapace smooth, unsculptured.

*Size variation*.—Mean length 529  $\mu\text{m}$ , range 440 to 580  $\mu\text{m}$  at Bodega Harbor, California (Table 1).

*Remarks*.—This cyprid is most likely to be confused with those of *P. polymerus* and *B. improvisus*, which it overlaps in size. Unlike *P. polymerus*, the carapace profile peaks well behind the compound eyes in side view and is relatively wide in dorsal view. The carapace is glassy smooth, lacking the sculpturing of both *P. polymerus* and *B. improvisus* cyprids. In side view the cyprid of *C. dalli* also differs from that of *B. improvisus* in having a more angular anterior end and an evenly curved posterodorsal margin with no break. *C. dalli* is also probably similar to *Chthamalus fissus*, but the cyprid of the latter species is undescribed at present.

#### Superfamily Balanoidea

##### Family Balanidae

##### Subfamily Balaninae Newman, 1979b

##### *Balanus improvisus* Darwin, 1854

##### Fig. 3

*Distribution*.—Adults: low intertidal zone and subtidal areas in estuaries and some enclosed bays; particularly tolerant of brackish water; on rocks, pilings, and hard-shelled animals. Cyprids: mainly low in water column in estuaries and some enclosed bays (Bousfield, 1955; Mohammad, 1961); summer, also spring and fall (Weiss, 1948; Jones and Crisp, 1954; Blom, 1965; Sneli, 1972). Introduced into the North Pacific; Columbia River, Oregon south to the Salinas River, California; occasionally in harbors south of Point Conception; Ecuador, Japan, Australia, North and South Atlantic.

*Identification*.—(1) Presence of large numbers of cyprids and adults in low salinity (3.4‰) waters in San Francisco Bay estuarine system (Newman, 1967; personal observation). (2) Comparison with laboratory-reared *B. im-*

*provisus* cyprids from Rhode Island. (3) Cyprid illustrations and descriptions in Buchholz (1951), Doochin (1951), and Jones and Crisp (1954); photograph in Freiburger and Cologer (1966). Naupliar stages described and figured in Buchholz (1951), Jones and Crisp (1954), and Lang (1979).

*Material examined*.—San Francisco Bay, California (October 1978).

*Diagnosis*.—Small, mean length 584  $\mu\text{m}$ . Relatively opaque when preserved, especially at anterior end. No special pigmentation in preserved specimens. Carapace profile relatively high in side view; anterior end rounded; posterior end narrowly rounded; anterodorsal margin curved; posterodorsal margin curved, breaking just in front of the posterior end; ventral margin curved anterior to, and slightly curved posterior to, the compound eyes. Extreme posteroventral margin of carapace finely crenulated. Carapace profile wide in dorsal view, mean width 285  $\mu\text{m}$ ; with both ends rounded. Carapace sculptured with rounded pits (about 4  $\mu\text{m}$  in diameter).

*Size variation*.—Mean length 584  $\mu\text{m}$ , range 540 to 610  $\mu\text{m}$  in San Francisco Bay, California (Table 1); mean length 587  $\mu\text{m}$  in Biscayne Bay, Florida (Doochin, 1951), 523  $\mu\text{m}$  on the east coast of England (Jones and Crisp, 1954), 514  $\mu\text{m}$  in the Netherlands (de Wolf, 1973).

*Shape variation*.—Sometimes the anterior end is narrowly rounded in side view, and both ends are broadly rounded to truncate in dorsal view.

*Remarks*.—This cyprid is most similar to that of *C. dalli* but could also be mistaken for those of *B. glandula* or *P. polymerus*. It differs from the cyprid of *C. dalli* in having a more rounded anterior end in side view, a posterodorsal margin that breaks just in front of the posterior end, and a carapace sculptured with small pits and fine crenulations, the latter along the posteroventral margin. The sizes of *B. improvisus* cyprids do not generally overlap those of *P. polymerus* or *B. glandula*, and the sculpturing of *B. improvisus* cyprids differs from the papillae of the latter two species. In addition, unlike *P. polymerus*, the carapace peaks well behind the compound eyes in side view and is considerably wider in dorsal view. Unlike *B. glandula*, the anterior end is more evenly rounded in side view and less truncate in dorsal view. The break in the posterodorsal margin also separates the cyprid of *B. improvisus* from that of *B. glandula*. Finally, *B. improvisus* cyprids are not likely to be found along the outer coast but do occur in the upper reaches of estuaries. Therefore, they co-occur with the cyprids of *C. dalli* and *B. glandula* mainly in enclosed bays and in the mouths of estuaries.

*Balanus glandula* Darwin, 1854

Fig. 4

*Distribution*.—Adults: upper and sometimes lower midtidal zone of exposed and protected shores; on rocks, pier pilings, and hard-shelled animals.

Cyprids: mainly high in water column; mean density  $28 \text{ m}^{-3}$ ,  $1,436 \text{ m}^{-3}$  on 26 March 1977; mainly spring, also summer and fall. Aleutian Islands south to San Quintin Bay, Baja California.

*Identification.*—(1) Coincidence of large numbers of cyprids and juveniles at collection site. (2) Adults present on pilings and floating pier adjacent to collection site. (3) Photograph of cyprid in Strathmann and Branscomb (1979). Naupliar stages have not been described or figured.

*Diagnosis.*—Medium-sized, mean length  $728 \mu\text{m}$ . Translucent when fresh. Chartreuse pigmentation observable only in fresh specimens; consisting of large (5–6 times the size of the compound eye) paired, irregularly shaped areas located in posterior third of body; several small, unpaired spots posterodorsal to compound eyes; and sometimes a pair of large (2–3 times size of compound eye) paired and fused areas anterodorsal to compound eyes. Golden (or rarely brown) when preserved, with light brown cement glands ventral to compound eyes. Carapace profile high in side view, mean depth  $388 \mu\text{m}$ ; both ends narrowly rounded; anterodorsal margin slightly curved; posterodorsal margin evenly curved; ventral margin curved both in front of and behind compound eyes, becoming relatively straight posteriorly. Carapace profile in dorsal view fusiform, with anterior end somewhat truncate and posterior end narrowly rounded; median raphe continuous from anterior end to posterior end. When viewed from the anterior end, raphe is seen as a seam where sides of carapace meet at an acute angle along dorsal margin. Entire carapace sculptured with elliptic papillae (about  $7 \mu\text{m}$  long and  $2 \mu\text{m}$  wide).

*Size variation.*—Mean length  $728 \mu\text{m}$ , range 640 to  $780 \mu\text{m}$  at Bodega Harbor, California (Table 1); mean length  $790 \mu\text{m}$ , range 670 to  $860 \mu\text{m}$  on San Juan Island, Washington (Strathmann and Branscomb, 1979).

*Remarks.*—This cyprid is medium-sized, ordinarily overlapping in size only with *Balanus crenatus*. In side view it differs from the cyprid of *B. crenatus* and most other species in having a high carapace profile and a ventral margin curved well behind the compound eyes. Other distinguishing features include an anterior end somewhat truncate in dorsal view, a dorsum acutely angled rather than rounded when viewed from the anterior end, and a carapace sculptured with papillae. Also distinctive are the chartreuse-pigmented areas in fresh specimens and the golden (or rarely brown) ground color in preserved ones. Most other species are more or less white when preserved. Unlike *Balanus nubilus*? and *B. improvisus* cyprids, the carapace of *B. glandula*, in side view, has a narrowly rounded anterior end and an evenly curved posterodorsal margin. Although considerably larger than *P. polymerus*, the cyprid of *B. glandula* is similar in having the carapace sculptured with papillae. However, the papillae are elliptic rather than rounded.

*Balanus crenatus* Brugière, 1789

## Fig. 5

*Distribution*.—Adults: low intertidal zone and especially subtidal areas to depths of 182 m; exposed and protected shores; on rocks, pier pilings, hard-shelled animals, and sometimes seaweeds. Cyprids: mainly low in the water column; mean density 92 m<sup>-3</sup>, 5,909 m<sup>-3</sup> on 26 March 1977; summer, fall, and especially spring. Northern Japan and Alaska south to Santa Barbara, California; North Atlantic.

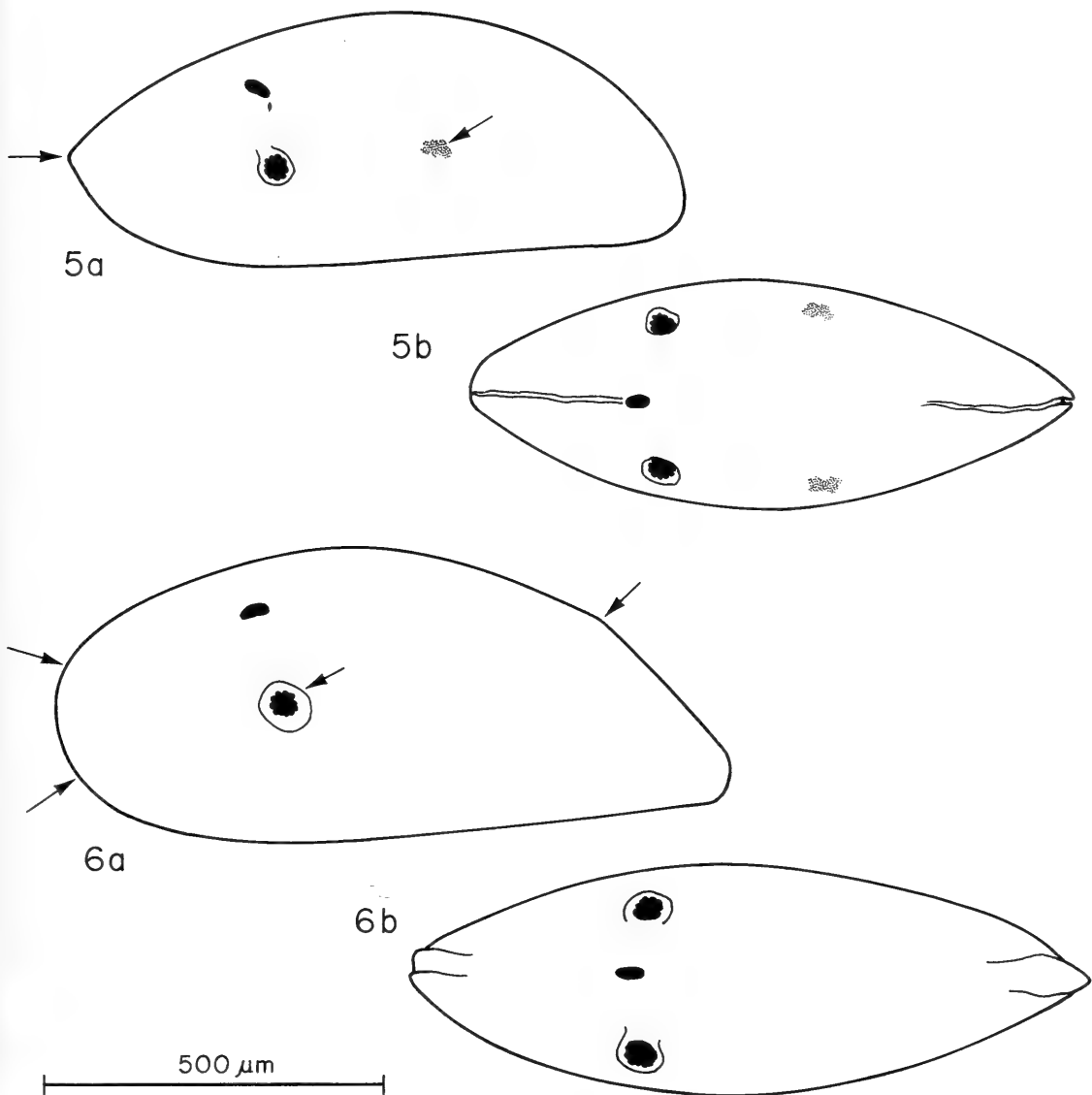
*Identification*.—(1) Juveniles reared in the laboratory from field-collected cyprids. (2) Coincidence of large numbers of cyprids and juveniles at collection site. (3) Adults present on pilings and floating pier adjacent to collection site. (4) Cyprid descriptions and illustrations in Herz (1933) and Pyefinch (1948). Naupliar stages described and figured in Herz (1933) and Pyefinch (1948, 1949).

*Material examined*.—Mostly from Bodega Harbor, California; some from Point Barrow, Alaska (August, 1976).

*Diagnosis*.—Medium-sized, mean length 852  $\mu$ m. Translucent when fresh. Relatively opaque (white) when preserved, especially at anterior end. A single pair of black pigment spots, somewhat smaller than compound eyes, located just posterior to midlength, and persisting after preservation. Carapace profile low in side view, mean depth 374  $\mu$ m; anterior end narrowly angular; posterior end narrowly rounded; anterodorsal margin only slightly curved; posterodorsal margin evenly curved; ventral margin curved anterior to, and relatively straight posterior to, compound eyes. Carapace profile in dorsal view fusiform, with both ends narrowly rounded. Carapace smooth, unsculptured.

*Size variation*.—Quite variable, mean length 852  $\mu$ m, range 700 to 960  $\mu$ m at Bodega Harbor, California (Table 1); mean length 1,001  $\mu$ m, range 900 to 1,060  $\mu$ m at Point Barrow, Alaska (Table 1); mean length 946  $\mu$ m, range 734 to 1,102  $\mu$ m in Scotland (Barnes, 1953); mean length 643  $\mu$ m in the Netherlands (de Wolf, 1973).

*Remarks*.—This cyprid is most similar to that of *B. nubilus*?, a slightly larger form. It differs in having a narrowly angular anterior end in side view and an evenly curved posterodorsal margin. The cyprids of *B. glandula* and *Semibalanus cariosus* also overlap *B. crenatus* in size. However, the cyprid of *B. crenatus* has the ventral margin relatively straight behind the compound eyes and a smooth carapace, unlike *B. glandula*, and the anterior end is narrowly rounded in dorsal view, unlike both of these other species. It also differs from the cyprid of *S. cariosus* in lacking a break in the posterodorsal margin and in having a carapace profile of medium width in dorsal view. The cyprid of *B. crenatus* is distinguished from all of the above-mentioned species by having a low carapace profile in side view and a pair of black pigment spots just posterior to midlength.



Figs. 5–6. Lateral (a) and dorsal (b) views of barnacle cyprids. 5, *Balanus crenatus*; 6, *Balanus nubilus*?. Pigment spots are stippled. Arrows indicate some diagnostic characters used in the key.

*Balanus nubilus*? Darwin, 1854  
Fig. 6

*Distribution*.—Adults: low intertidal zone and subtidal areas to depths of 90 m; exposed and protected shores; on rocks, pier pilings, and hard-shelled animals. Cyprids: mainly low in water column; mean density 6 m<sup>-3</sup>; spring, summer, and fall, especially summer. Southern Alaska south to La Jolla, California.

*Identification*.—(1) Juveniles reared in the laboratory from field-collected cyprids. (Although identification of the juveniles was not completely certain, the presence of large numbers of this cyprid as far north as Crescent City,



California suggests that the correct identification is *B. nubilus* rather than the more southern form *Balanus aquila*.) (2) Adults present on pilings and floating pier adjacent to collecting site. Naupliar stages described and figured in Barnes and Barnes (1959).

*Materials examined*.—Mostly from Bodega Harbor, California; some from Moss Landing, California and Crescent City, California.

*Diagnosis*.—Medium-sized, mean length 932  $\mu\text{m}$ . Translucent when fresh. Relatively translucent when preserved, although more opaque anteriorly and posteriorly; with light orange cement glands posteroventral to compound eyes. No special pigmentation. Carapace profile relatively low in side view; anterior end rounded; posterior end narrowly rounded; anterodorsal margin curved; posterodorsal margin curved, breaking slightly about three-fourths of the way towards posterior end; ventral margin curved anterior to, and nearly straight posterior to, compound eyes. Carapace profile in dorsal view fusiform, with both ends narrowly rounded. Carapace smooth, unsculptured.

*Size variation*.—Mean length 932  $\mu\text{m}$ , range 800 to 1,000  $\mu\text{m}$  at Bodega Harbor, California (Table 1).

*Remarks*.—This cyprid is most similar to that of *B. crenatus*. It differs, in side view, in having a break in the posterodorsal margin and a more rounded anterior end. This latter character also distinguishes the cyprid of *B. nubilus*? from that of *S. cariosus*, which overlap each other in size. In addition the cyprid of *B. nubilus*? has a relatively narrow width and a narrowly rounded anterior end in dorsal view, unlike *S. cariosus*. All of these characters, together with the smooth carapace of *B. nubilus*?, separate it from the cyprid of *B. glandula*, a smaller species.

Family Archaeobalanidae Newman and Ross, 1976

Subfamily Semibalaninae Newman and Ross, 1976

*Semibalanus cariosus* (Pallas, 1788) (= *Balanus cariosus*)

Fig. 7

*Distribution*.—Adults: lower midtidal and sometimes low intertidal zones of wave-exposed shores; on rocks and hard-shelled animals. Cyprids: probably low in water column; mainly spring and summer (Connell, 1970; Dayton, 1971; Strathmann and Branscomb, 1979). Japan, Bering Sea, and Alaska south to Morro Bay, California.

*Identification*.—(1) Coincidence of large numbers of cyprids and juveniles (R. R. Strathmann, pers. comm.). (2) Photograph of cyprid in Strathmann and Branscomb (1979). Naupliar stages have not been described or figured.

*Material examined*.—San Juan Island, Washington (May 1976).

*Diagnosis*.—Large, mean length 1,111  $\mu\text{m}$ . Very opaque when preserved, except for translucent area along dorsum. No special pigmentation in pre-

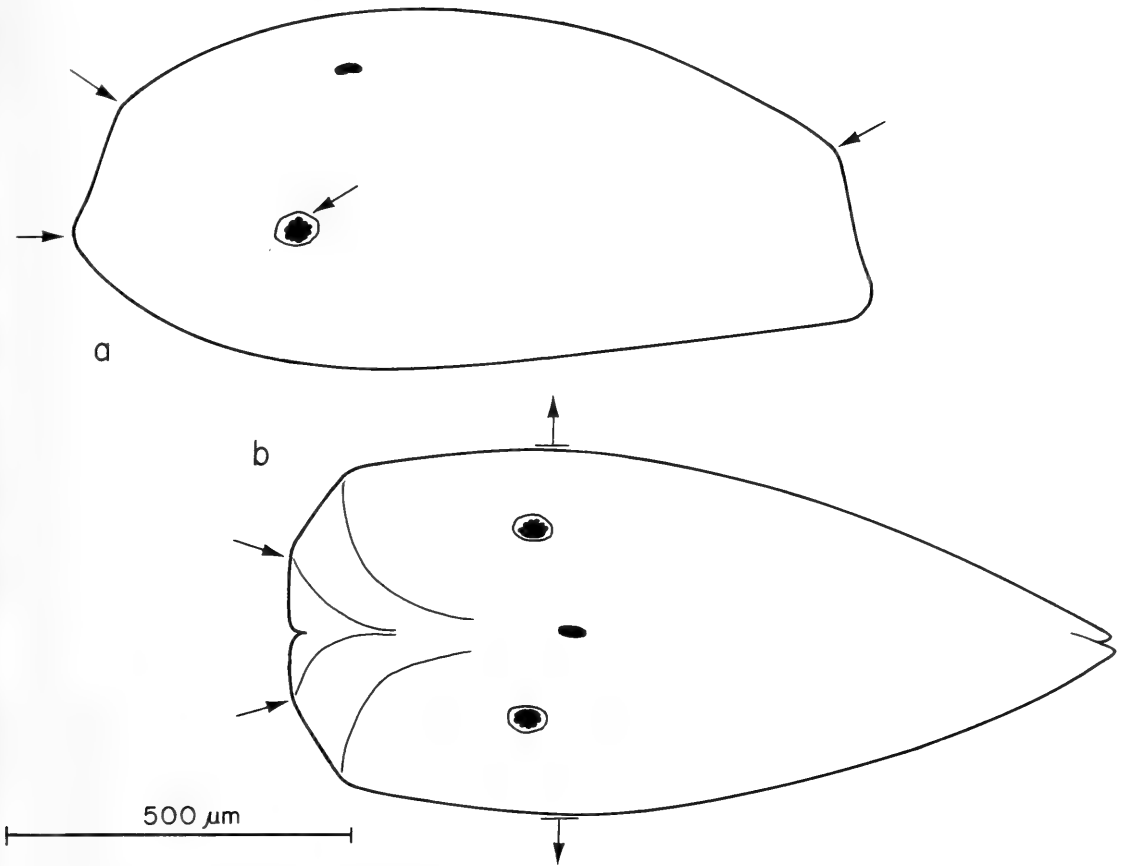


Fig. 7. Lateral (a) and dorsal (b) views of *Semibalanus cariosus*. Arrows indicate some diagnostic characters used in the key.

served specimens. Carapace profile relatively low in side view; anterior end broadly angular; posterior end narrowly rounded; anterodorsal margin curved, breaking somewhat just behind anterior end; posterodorsal margin curved, breaking prominently just in front of posterior end; ventral margin curved anterior to, and slightly curved posterior to, compound eyes. Carapace profile wide in dorsal view, mean width  $493\ \mu\text{m}$ ; anterior end truncate; posterior end narrowly rounded. Compound eyes small and deeply inset. Carapace smooth, unsculptured.

**Size variation.**—Mean length  $1,111\ \mu\text{m}$ , range  $960$  to  $1,200\ \mu\text{m}$  at San Juan Island, Washington (Table 1); a larger sample ( $N = 80$ ) from San Juan Island had a mean length of  $1,140\ \mu\text{m}$ , range  $980$  to  $1,240\ \mu\text{m}$  (Strathmann and Branscomb, 1979).

**Remarks.**—This cyprid is the largest one considered here, although its size overlaps with that of *B. nubilus*? and *B. crenatus*. It differs from the former species in having a broadly angular anterior end in side view and in having a wide carapace profile, a truncate anterior end, and relatively small, deeply inset compound eyes, all visible in dorsal view. These characters,

together with the breaks in the anterodorsal and posterodorsal margins of *S. cariosus*, serve to distinguish it from the cyprid of *B. crenatus*.

### Discussion

Over 50 species of thoracican cyprids have been previously illustrated or described, mostly from the North Atlantic, India, and Australasia (cf. Nilsson-Cantell, 1921, 1978; Lang, 1979). The present paper describes seven species of cyprids from the Oregonian Province of the temperate Northeast Pacific region. They include most of the intertidal barnacles characteristic of this province, along with some of the more subtidal forms. The ranges of most of these species extend into the adjoining Aleutian and Californian Provinces, where still other species occur. Nevertheless, the descriptions given here will account for most of the intertidal species encountered in the Aleutian and Californian Provinces; they will be less useful for the subtidal species.

The taxonomic features studied here were size, shape, special pigmentation, and sculpturing. Size is usually expressed in the descriptive literature as carapace length; carapace depth appears occasionally, width rarely. Cyprids range in length from less than 100  $\mu\text{m}$  (Bocquet-Védrine, 1961) to more than 2,200  $\mu\text{m}$  (Standing, personal observation). The very smallest cyprids, in general, are rhizocephalans, while lepadids and some scalpellids tend to be very large (Nilsson-Cantell, 1921; Zevina, 1971). Other scalpellids are considerably smaller. For example, *Calantica spinosa* and *Pollicipes polymerus* have lengths of 850  $\mu\text{m}$  and 494  $\mu\text{m}$ , respectively (Batham, 1946b; the present study). The trends in the Balanomorpha are as follows: chthamaloidean cyprids are small (less than 625  $\mu\text{m}$ ), but not as small as rhizocephalans; coronuloideans are mostly small to medium sized; and balanoideans range from small to large, although *Chirona hameri* is very large, averaging 1,454  $\mu\text{m}$  (Crisp, 1962). The smallest and largest balanoidean cyprids observed in the present study were *Balanus improvisus* and *Semibalanus cariosus*, respectively (Table 1).

Cyprid size is quite variable, even within a single species. In the laboratory, size varies inversely with rearing temperature (Lang, 1979), and in the field, size often varies directly with latitude (Pyefinch, 1948; Crisp, 1962). This size-latitude phenomenon, probably involving both temperature and food supply, also applies to barnacle nauplii and embryos (Barnes and Barnes, 1965), as well as many other marine animals. The present study provides additional evidence of the size-latitude phenomenon. *Balanus crenatus* cyprids from Point Barrow, Alaska, were larger than those from Bodega Harbor, California (Table 1), and *B. glandula* cyprids from San Juan Island, Washington (Strathmann and Branscomb, 1979) were larger than those from Bodega Harbor.

Some species of cyprids in the present study overlapped considerably in size (Table 1). For this reason, size is best considered a taxonomic feature of secondary importance. However, it is useful for initially distinguishing between groups of species and for helping to recognize species after initial identification. Carapace width was a good character for separating *Pollicipes polymerus* and *Semibalanus cariosus* cyprids from other species of similar length.

Carapace shape characters, unlike size, proved to be particularly important for discriminating between species. Therefore, shape characters have been described in detail and illustrated carefully, operations not always accomplished in previous studies. Still, the existing literature does suggest the variation to be expected in shape characters, and some general trends in cyprid shapes.

Side views of shape characters are especially revealing. The anterior ends of cyprids vary from pointed or angular through rounded to truncate. Anterodorsal margins are usually inflated to various extents but can be depressed. *Pollicipes polymerus* has a broadly rounded anterior end and a broadly curved anterodorsal margin, resembling *Calantica* (formerly *Pollicipes*) *spinosa* but not *Capitulum* (formerly *Pollicipes*) *mitella* (Yasugi, 1937; Batham, 1946b). Also similar in these respects are some other scalpellids and most lepadids (Darwin, 1851; Aurivillius, 1894; Nilsson-Cantell, 1921; Broch, 1931; Zevina, 1971). *Chthamalus dalli* has an angular anterior end similar to that of some other chthamalids (Barker, 1976; Karande and Thomas, 1976; Lang, 1979), but it is unclear whether or not this character is representative of the group. The break in the anterodorsal margin of *Semibalanus cariosus* cyprids is a character different from any other illustrated in the literature.

Posterior ends of cyprids range from sharply pointed through narrowly rounded to broadly rounded; posterodorsal margins are usually inflated to varying degrees but can be depressed. Some species of cyprids have angular (i.e., "broken") posterodorsal margins: *Pollicipes polymerus*, *Balanus improvisus*, *B. nubilus*?, and *Semibalanus cariosus* in the present study. The literature suggests that this character is more common in lepadomorphs (Aurivillius, 1894; Broch, 1931; Anderson, 1965; Standing, personal observations) than in balanomorphs (Buchholz, 1951; Moyse, 1961), but it is also likely that the character has frequently been overlooked in previous studies. Another interesting character on the posterior end is the finely crenulated margin of *Balanus improvisus*, a character similar to that present in the acrothoracican *Trypetesa nassaroides* (Turquier, 1967). This character is reported here for the first time in *B. improvisus* from San Francisco Bay (and from Rhode Island), even though the cyprid has been illustrated many times before. It is not yet clear whether this character is representative of

the species and previously overlooked, or present in only some populations. The existing illustrations of this species suggest that other characters may be quite variable as well.

Ventral margins also differ between species. They may be straight through curved to recurved. Most species have convexly curved ventral margins. However, *Pollicipes polymerus* cyprids and those of some other lepadomorphs have relatively straight ventral margins (Darwin, 1851; Aurivillius, 1894; Broch, 1931; Batham, 1946b; Zevina, 1971).

Dorsal views of cyprids show fewer shape characters than side views. Nevertheless, some of these characters have taxonomic value. Particularly interesting are anterior ends, which can vary from angular through rounded to truncate. Most species have rounded anterior ends, but those of *Balanus glandula* and *Semibalanus cariosus* are nearly truncate. The curvature of the sides and the shape of the posterior end also vary in cyprids, but these characters appear to have less taxonomic value than some of the other characters, at least in balanomorphs.

Carapace sculpturing characters are infrequently referred to in the descriptive literature. The present study suggests that they may be more widespread than is generally believed, but often overlooked. At present a number of lepadomorphs are known to have parallel carinae along the length of the carapace (Darwin, 1851; Broch, 1931; Batham, 1946a, b; Zevina, 1971; Standing, unpublished observations), and "brickwork" sculpturing has been described for *Ibla cumingi* (Karande, 1974). In addition, *Semibalanus balanoides* has tiny pits (Walker and Lee, 1976), which appear to be similar to those observed for the first time here on *Balanus improvisus* from San Francisco Bay (but not on specimens from Rhode Island). However, the papillae described here for *Pollicipes polymerus* and *Balanus glandula* cyprids are different from any sculpturing previously described, including the papillae that occur on the ascothoracican *Ulophysema öresundense* (Brattström, 1948) and the "peg-plates" present on some acrothoracicans (Tomlinson, 1969). Some acrothoracican and rhizocephalan cyprids also have the carapace ornamented with large spines, but these are very different from the small spine-like processes seen on *Pollicipes polymerus*. Clearly, much additional work is needed to fully assess the importance of carapace sculpturing and ornamentation to cyprid taxonomy. SEM studies, for example, might reveal ultramicroscopic sculpturing in species that appear smooth under the light microscope.

Special pigmentation characters, like sculpturing characters, are not often mentioned in the literature, probably because most species lack them. The positions of pigment spots or areas seem to vary widely in different species, but in general, cyprids with special pigmentation can be conveniently divided into two color classes: those having bright yellow or orange areas of pigmentation (Batham, 1946b; Walley, 1969; Lang, 1976) and others having

dark purple or black pigmentation (Pillai, 1958; Barker, 1976). In the present study, chartreuse areas were observed in fresh *Balanus glandula* cyprids, and black spots were present on *B. crenatus*. The pigmentation in *B. glandula* cyprids appears to be similar to the “yellow cells” found in *Semibalanus balanoides* (Walley, 1969); the spots in *B. crenatus* cyprids may be most similar to the “black patches” described for *Balanus amphitrite amphitrite* (Pillai, 1958), and also present on *B. improvisus* from Rhode Island (Standing, personal observation). The special pigmentation observed in the cyprids of *B. glandula* and *B. crenatus* has not been previously reported, although both species have been briefly described before.

Distributional information can also be useful in larval identification, but it must be interpreted carefully. Cyprids are likely to be found outside the geographical ranges of adults only occasionally, and inshore species are not often collected far out to sea, at least in the Oregonian Province. A few species may be found in special situations where other species are not to be expected. *Balanus improvisus* cyprids, for example, occur in very low salinities that probably cannot be tolerated by other species. Although they have been collected in bays and estuaries on this coast, they were not taken at Bodega Harbor and are probably not ordinarily present along the outer coast. Another cyprid not collected at Bodega Harbor was *Semibalanus cariosus*, although adults are present in the area. The adults of this species become uncommon south of San Francisco, and recruitment may be infrequent in central California. Vertical distributions in the water column and seasonal abundances of cyprids also differ, but identifications should not be based on this information because of considerable overlap between species. The ecological data collected in the present study will be presented in greater detail elsewhere.

In conclusion, the present work has shown considerable differences between some species of cyprids present in the Oregonian Province. Application of microdissection and electron microscope techniques will undoubtedly reveal further variation. Even now, the differences separating the cyprids of *Balanus improvisus*, *B. glandula*, and *B. crenatus* may be greater than those known to separate the juveniles or adults of these species. Further study of cyprids, like nauplii (Lang, 1979), should enable us to view the life histories and phylogenies of cirripedes in new and revealing ways.

Key to Cyprids of the Oregonian Province

- 1. Small, length less than 625  $\mu\text{m}$  ..... 2
- Medium to large, length greater than 625  $\mu\text{m}$  ..... 5
- 2. Anterior end narrowly rounded to angular in side view; posterodorsal margin evenly curved (Figs. 2a, 4a) ..... 3

- Anterior end broadly rounded to rounded in side view; posterodorsal margin with break in curve (Figs. 1a, 3a) ..... 4
- 3. Distinct golden (rarely brown) ground color when preserved, chartreuse pigmented areas when fresh; carapace surface dull under low magnification, sculptured with papillae under high magnification ..  
..... *Balanus glandula*<sup>2</sup> (Fig. 4)
- Relatively translucent when preserved, no special pigmentation when fresh; carapace surface shiny under low magnification, smooth under high magnification ..... *Chthamalus dalli* (Fig. 2)
- 4. Carapace depth greatest about one-third of the way back from anterior end; carapace breadth narrow in dorsal view, about one-third length; mainly outer coast ..... *Pollicipes polymerus* (Fig. 1)
- Carapace depth greatest about halfway back from anterior end; carapace breadth wide in dorsal view, about one-half length; bays and estuaries ..... *Balanus improvisus* (Fig. 3)
- 5. Anterior end narrowly angular to narrowly rounded in side view; posterodorsal margin evenly curved (Figs. 4a, 5a) ..... 6
- Anterior end broadly angular to rounded in side view; posterodorsal margin with break in curve (Figs. 6a, 7a) ..... 7
- 6. One pair of black pigment spots just posterior to midlength when fresh; white ground color when preserved, with pigment spots persisting; carapace surface shiny under low magnification, smooth under high magnification ..... *Balanus crenatus* (Fig. 5)
- Several chartreuse pigmented areas when fresh; golden (rarely brown) ground color when preserved, with no special pigmentation persisting; carapace surface dull under low magnification, sculptured with papillae under high magnification *Balanus glandula* (Fig. 4)
- 7. Anterior end truncate, posterior end narrowly rounded in dorsal view; carapace breadth wide in dorsal view, about one-half length; compound eyes small, eye capsules less than 68  $\mu\text{m}$  .....  
..... *Semibalanus cariosus* (Fig. 7)
- Anterior and posterior ends both narrowly rounded in dorsal view; carapace breadth relatively narrow in dorsal view, about one-third length; compound eyes large, eye capsules more than 68  $\mu\text{m}$  .....  
..... *Balanus nubilus*? (Fig. 6)

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<sup>2</sup> Only rarely less than 625  $\mu\text{m}$  in length.



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# A NEW SPECIES AND A NEW GENUS OF CERVINIIDAE (COPEPODA: HARPACTICOIDA) FROM THE BEAUFORT SEA, WITH A REVISION OF THE FAMILY<sup>1</sup>

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*Abstract.*—*Cervinia unisetosa* n. sp. from the bathyal zone of the Beaufort Sea (Arctic Ocean) is unique in the *Cervinia* in that it possesses a reduced fifth leg, moderate length caudal rami, and only one seta on the bases of the mandible and the maxilliped. The discovery of the male of *Pseudocervinia magna* (Smirnov, 1946) proves that the species should be redesignated as a *Cervinia* as originally described. *Expansicervinia glaciera* n. gen. & n. sp. from the deep-sea of the same area proves to be unique in the Cerviniidae in three expansions; the ventral margins of second thoracic segment; the basal segment of the antennule; and the terminal endopodite of the second leg. The genus *Stratiopontotes* Soyer, 1970 is synonymized with *Ameliotes* Por, 1969. Keys to the genus *Cervinia* and the family Cerviniidae are presented.

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Benthic infaunal studies off the northern coast of Alaska conducted by the Oregon State University Marine Benthic Ecology Group have yielded many harpacticoid copepods of the family Cerviniidae Sars, Lang (Montagna and Carey, 1978). Two species, *Cervinia langi* Montagna, 1979 and *Pseudocervinia magna* (Smirnov, 1946) have been discussed in detail elsewhere (Montagna, 1979). More recent sampling has yielded enough specimens of a new species of *Cervinia* and a new genus to warrant description.

*Cervinia unisetosa* n. sp. is most closely related to *Cervinia tenuicauda* Brodskaya, 1963 in that the P<sub>5</sub> is much reduced, a character previously unique in the genus. However, *C. unisetosa* differs from *C. tenuicauda* in the length of the CR and details of the Md and Mxp.

The discovery and analysis of the male of *P. magna* requires that this species be reinstated to its original designation of *Cervinia magna*. Descriptions of the new species and the males of *C. magna* are presented with a revised key to the genus.

*Expansicervinia glaciera* n. gen. & n. sp. is a member of the subfamily Cerviniinae Brodskaya, 1963 and is unique in the subfamily in that the P<sub>2</sub>—

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P<sub>4</sub> terminal exopodites have only two outer spines; the antennules have 8 segments and possess lateral expanded knobs on the basal segments; there is no rostrum; and the ventral margin of the second thoracic segment is greatly enlarged.

The family Cerviniidae has not been revised since Brodskaya (1963). Since then, two new genera have been added; however, as will be discussed, *Stratiopontotes* Soyer, 1970 is a synonym of *Ameliotes* Por, 1969. In the present text a new genus is added, and *Pseudocervinia* Brodskaya, 1963 is synonymized with *Cervinia* Norman, 1878. A discussion of the taxonomic decisions and a key to the subfamilies and genera is presented.

All figures were made with the aid of a camera lucida. The nomenclature and descriptive terminology are adopted from Lang (1948, 1965) and Coull (1977). The following abbreviations are used throughout the text, figures and tables: R = rostrum, A<sub>1</sub> = antennule, A<sub>2</sub> = antennae, Md = mandible, Mx1 = maxillula, Mx = maxilla, Mxp = maxilliped, P<sub>1</sub>–P<sub>6</sub> = legs 1–6, exp. = exopodite, end. = endopodite, benp. = baseoendopodite, GF = genital field, and CR = caudal ramus. Body length measurements are from the base of the R to the base of the CR, excluding both. CR L/W (=length to width ratio) is measured from the inner proximal edge to the inner distal edge for length, and the outer proximal edge for width.

Family Cerviniidae Sars, 1903; Lang, 1948

Subfamily Cerviniinae Brodskaya, 1963

Genus *Cervinia* Norman, 1878

*Cervinia unisetosa*, new species

Figs. 1–2

*Cervinia* sp. B. Montagna and Carey, 1978:119.

*Material*.—31 ♀♀. Holotype, 1 ♀ USNM 180117 (United States National Museum of Natural History). Paratypes 16 ♀ USNM 180118.

*Type-locality*.—Bathyal zone of the Beaufort Sea off the northern coast of Alaska, USA (71°45.1'N, 150°35.0'W) 2,325 m, described as station 6 in Bilyard and Carey (1979).

*Description*.—Female: Based on nonovigerous female 1.63 mm long. Body typical *Cervinia* shape (Fig. 1), cephalothorax broadened anteriorly, segment bearing P<sub>1</sub> distinct. Body tapers greatly through metasome, but to lesser extent in urosome. CR divergent, longer than last 2 segments, L/W = 7.5. R triangular, fused to cephalothorax. A<sub>2</sub> extending beyond A<sub>1</sub>.

A<sub>1</sub> (Fig. 1): 7-segmented with aesthetasc on segment-3. 5 setae on terminal segment.

A<sub>2</sub> (Fig. 1): Allobasis with 2 setae, exp. 4-segmented with 2.1.1.3 setae respectively. Terminal segment with 3 proximal, 6 distal broad spines.

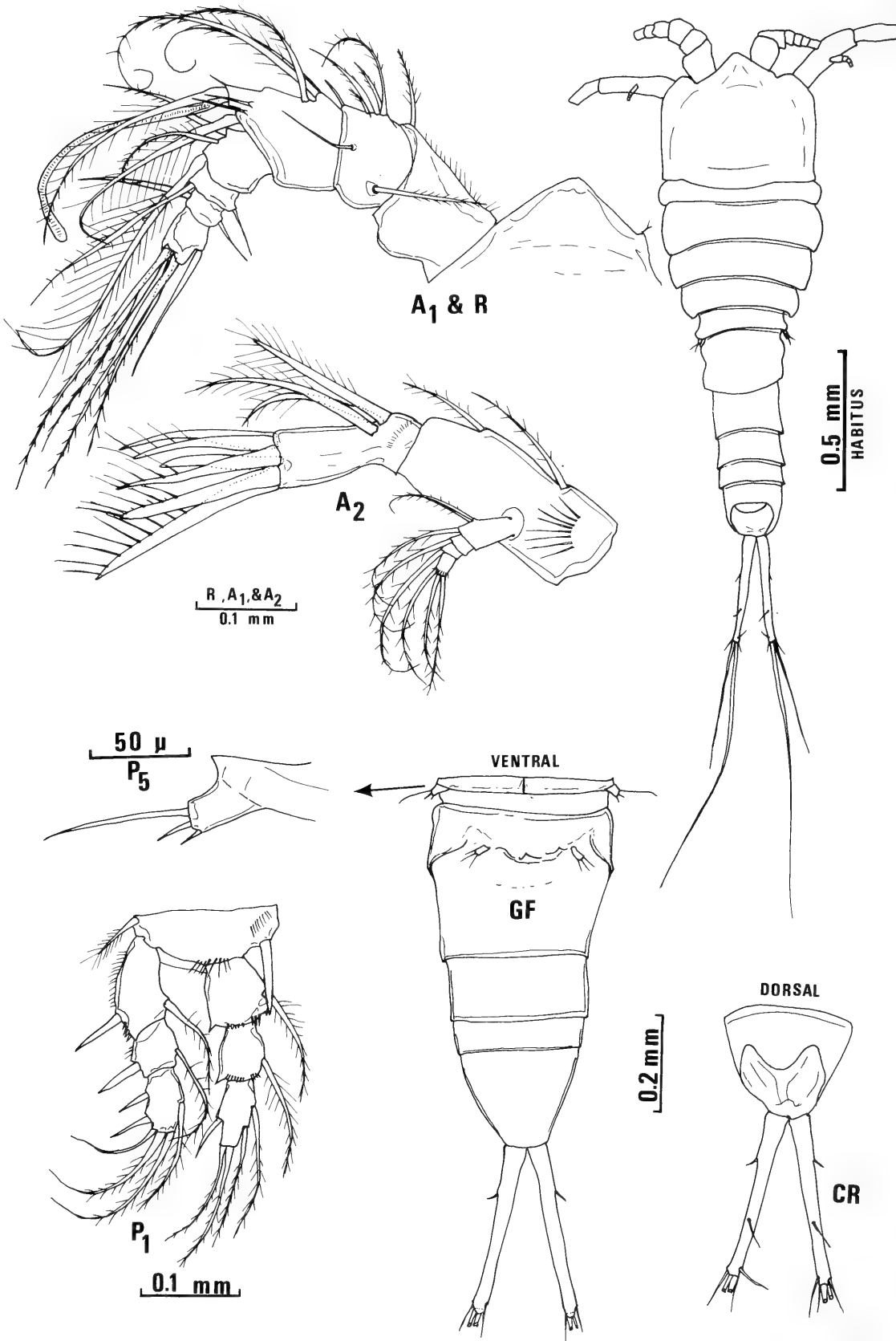


Fig. 1 *Cervinia unisetosa* ♀.

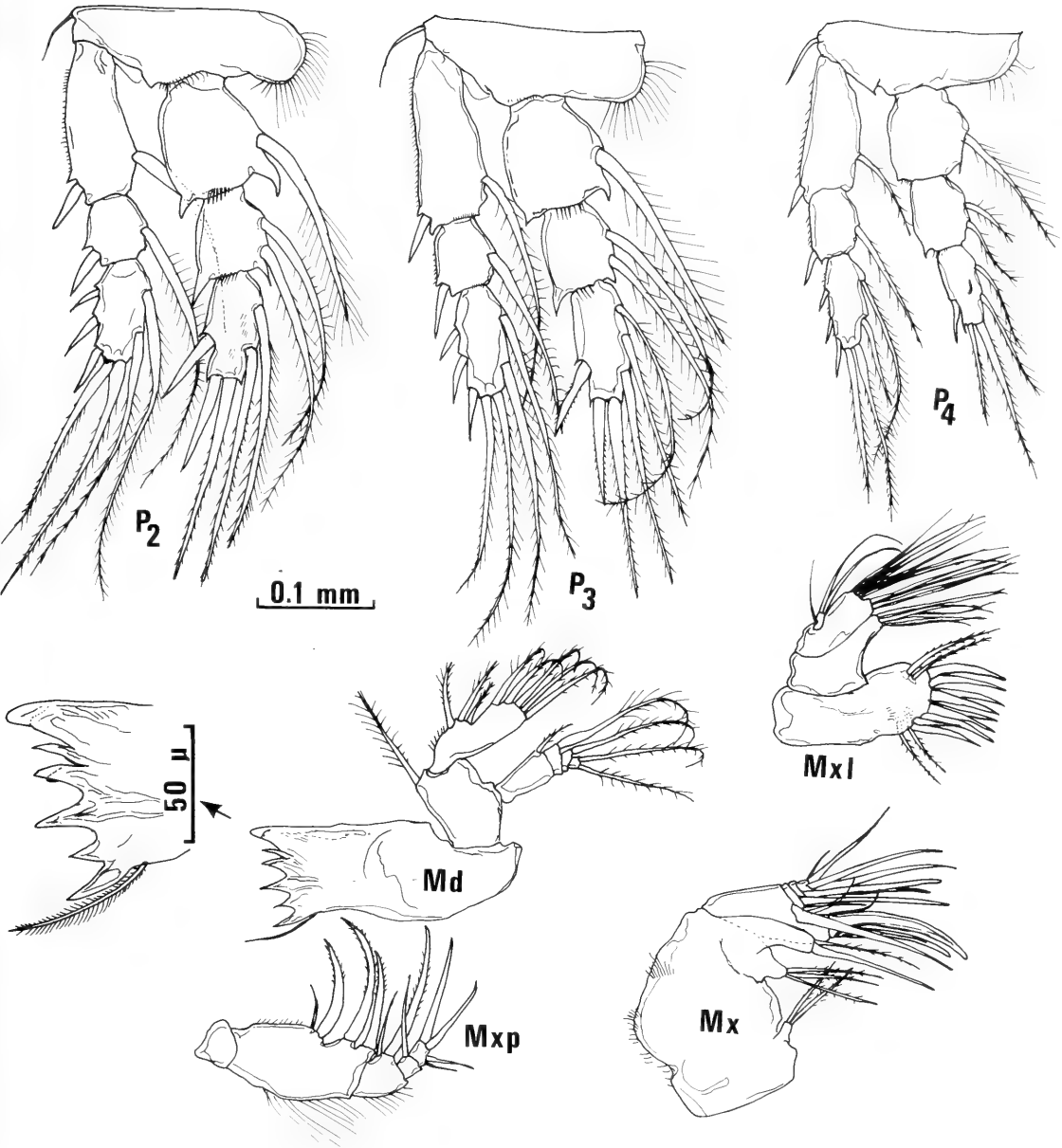


Fig. 2 *Cervinia unisetosa* ♀.

Md (Fig. 2): Precoxa with bidentate pars incisiva, unidentate lacina mobilis, 4 additional spines, 1 seta. Coxa-basis with 1 inner seta. End. 1-segmented with 3 inner, 5 terminal setae. Exp. 4-segmented with 1.1.1.2 setae respectively.

Mxl (Fig. 2): Arthrite of precoxa with 9 distal spines, 4 surface setae arranged in opposing pairs on opposite surfaces. Coxa with 6 inner setae. Basis and end. fused with 12 setae. Exp. reduced with 3 setae.

Mx (Fig. 2): Syncoxa with 3 endites, with 2.3.2 setae respectively. Basis

with 2 claws, 1 seta. End. 3-segmented with 1 spine, 1 seta; 2 spines; 3 spines, 2 setae respectively.

Mxp (Fig. 2): Not prehensile, basis with 3 claw-like spines, 1 seta associated with innermost. End. 3-segmented with 1 claw, 1 seta; 1 seta; 2 claws, 2 setae respectively.

P<sub>1</sub> (Fig. 1), P<sub>2</sub>–P<sub>3</sub> (Fig. 2): Each ramus of all legs 3-segmented. Setation as figured and listed below:

	<i>Exopod</i>	<i>Endopod</i>
P <sub>1</sub>	1.1.123	1.1.221
P <sub>2</sub>	1.1.223	1.2.221
P <sub>3</sub>	1.1.223	1.2.321
P <sub>4</sub>	1.1.221	1.2.221

P<sub>5</sub> (Fig. 1): Basis and exp. fused into broad plate which is indistinctly separated. No inner expansions of benp., or outer seta. Exp. part much reduced with 3 distal setae.

P<sub>6</sub> & GF (Fig. 1): Located medioventrally. P<sub>6</sub> with 3 terminal setae located just lateral to GF. GF medial with sclerotized posterior curving ridge. Genital pore triangular but indistinct.

*Male*.—Unknown.

*Variability*.—3 specimens were dissected; all were identical except for the following: the CR L/W varied between 7.1 and 7.9, and 1 specimen had only 1 setae on the middle segment of the P<sub>4</sub> endopodite instead of the normal 2.

*Etymology*.—The specific name *unisetosa* (L. '*unus*' = one + L. '*seta*' = bristle) refers to the single seta on the coxa-basis of the Md and in association with the 3 claws of the Mxp.

*Discussion*.—*Cervinia unisetosa* is most nearly related to *C. tenuicauda* based on the identical structure of the P<sub>5</sub> which is unique in the Cerviniidae but common to both. However, the CR of *C. unisetosa* is only half as long as that of *C. tenuicauda*, the longest in the genus. *Cervinia unisetosa* is unique in the genus in 2 characters: there is only one seta on the coxa-basis of the mandible, and there is only one seta associated with the 3 claws of the maxilliped basis.

In a previous study of *Cervinia* I concluded that the setation of the swimming legs is a conservative character in this genus (Montagna, 1979). However, the setation of the mandible and the maxilliped are unique among all the species of the genus. Taxonomic decisions in the Harpacticoida usually are not based on the details of the mouthparts. Because of their small size, the details may be difficult to ascertain, particularly for earlier workers who did not have the advantage of modern research microscopes. However, I feel an exception must be made for *Cervinia* because of their unusually

large size. The mouthparts are as large as the swimming legs (Fig. 2), and well figured in even the earliest descriptions of the genus.

*Cervinia magna* Smirnov, 1946  
Figs. 3–4

*Pseudocervinia magna* (Smirnov).—Brodsкая, 1963:1801.

*Material*.—9 gravid ♀♀, 492 ♀♀, 205 copepodites, and 75 ♂♂, collected from the continental slope off Pitt Point, Alaska, USA, described as stations 30–34 by Montagna & Carey (1978), depth 25–100 m. Specimens of the males have been deposited in USNM 180119.

*Description*.—Male: Body 1.20 mm long. Typical *Cervinia* male; cephalothorax broadened anteriorly, R slightly broader than ♀, A<sub>1</sub> with many aesthetascs, first segment distinct, body tapered throughout, urosome with many rows of spinules (Fig. 3). Sexual dimorphism pronounced; all characters are dimorphic except A<sub>2</sub>, P<sub>1</sub>–P<sub>4</sub> exp. and Cr, which are female-like.

A<sub>1</sub> (Fig. 3): 8-segmented, aesthetascs on segments 4 and 6, 2 on segment 8.  
Md (Fig. 3): Precoxa greatly reduced, pars incisiva and lacina unidentate. Coxa-basis, end. and exp. as in ♀.

Mxl (Fig. 3): Greatly reduced, arthrite with 6 spines, coxa with 5 setae. Basis with 2 inner, end. represented by 6 terminal setae, exp. represented by 2 outer setae.

Mx (Fig. 3): Basis claw transformed into shape resembling ‘bottle opener,’ with proximal seta, 1 seta on surface. End. 3-segmented with 1.2.3 setae.

Mxp (Fig. 3): Basis reduced (as large as 3 end. segments combined) with 3 claws; innermost transformed, widened and prehensile; middle claw with 1 seta. End. 3-segmented 2.1.4 setae and spines respectively.

P<sub>1</sub>–P<sub>4</sub> (Fig. 3): All rami 3-segmented, setation as listed below. Only end. figured, P<sub>3</sub> and P<sub>4</sub> terminal end. with transformed spines.

	<i>Exopod</i>	<i>Endopod</i>
P <sub>1</sub>	1.1.123	1.1.221
P <sub>2</sub>	1.1.223	1.2.221
P <sub>3</sub>	1.1.223	1.2.321
P <sub>4</sub>	1.1.223	1.2.221

P<sub>5</sub> (Fig. 3): Setation and shape as ♀ except terminal seta greatly enlarged and proximal seta reduced.

P<sub>6</sub> (Fig. 3): Lateral with 3 setae.

Copepodite: The last copepodite stage of *C. magna* resembles an adult in that the urosome has 5 segments (Fig. 4). Just one stage younger specimens have 4 urosomal segments with the last two segments combined. All the appendages of the cephalothorax are the same as the adult ♀, as are the



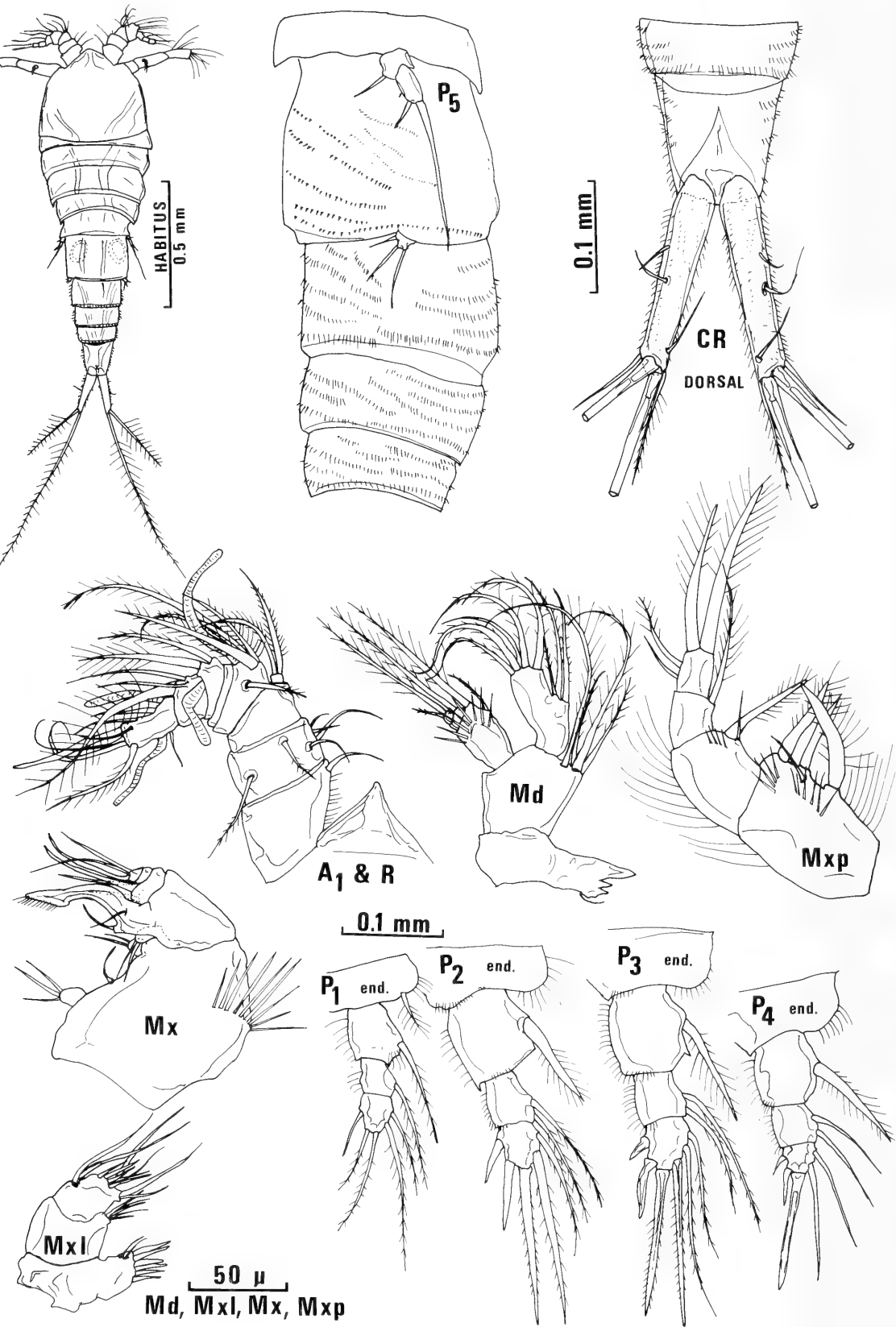


Fig. 3. *Cervinia magna* ♂.

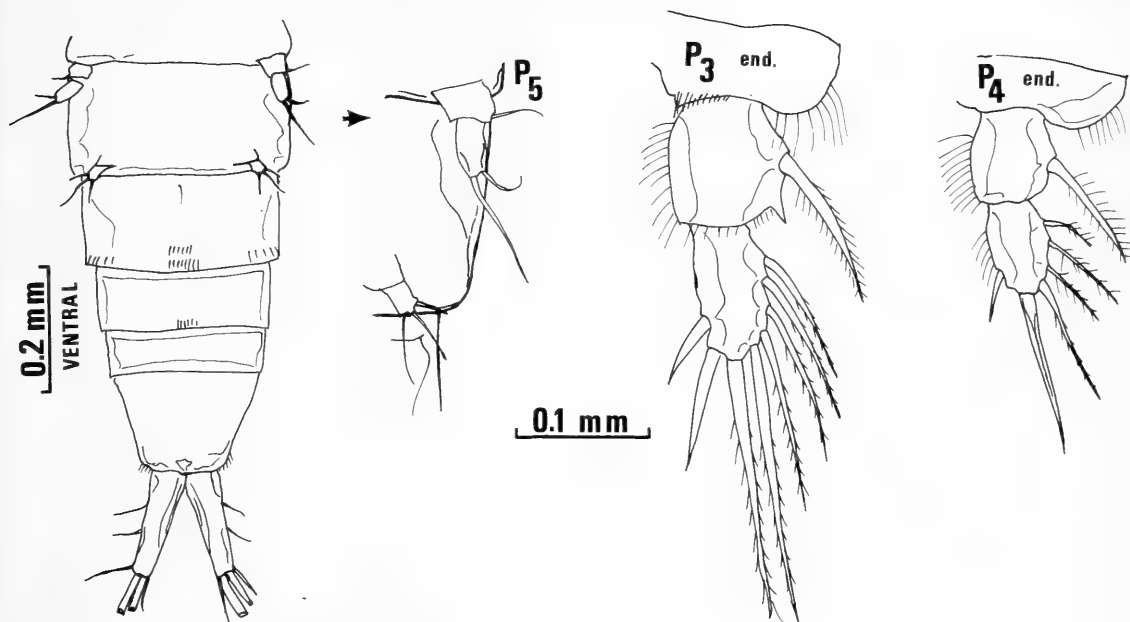


Fig. 4. *Cervinia magna* copepodite.

$P_1$  and  $P_2$ . But  $P_3$  and  $P_4$  endopodites vary as figured (Fig. 4) with the setal formulae being 1.521 and 1.321 respectively.

**Discussion.**—In my previous study of this species, I corrected several character misdiagnoses of the female (Montagna, 1979). These character traits were significant because they were the basis of a generic description by Brodskaya (1963). If *C. magna* had possessed opposed CR as previously thought, it would have been in the subfamily Cerviniopsinae, thus requiring a distinct genus. However, since the CR are divergent, *C. magna* belongs in the Cerviniinae (Montagna, 1979). Only one character in the genus description of *Pseudocervinia* remained unique; that the male had a 2-segmented end. on the first leg. On that basis I previously decided that it would be premature to declare *Pseudocervinia* synonymous with *Cervinia* since I had not yet seen the male of the species. Though Smirnov (1946) did not figure the male, he described the  $P_1$  end. as 2-segmented, and the  $P_2$ – $P_4$  end. as 3-segmented with the setation as described above.

Considering the highly dimorphic nature of the males, I was not sure that I had the male of *C. magna*. In fact, at first I thought the copepodite (Fig. 4) was the male because it was identical to the female except for the  $P_5$ ,  $P_3$  and  $P_4$  endopodite setation. Most convincing was that the urosome was composed of five segments as in adult males. But in all 11 of these morphs I never found spermatophores, as I did in all 75 of the true males. Further, dissection of the morphs which undoubtedly were juveniles (i.e., with four urosomal segments, and unfused genital segments) showed the exact structure of  $P_3$ – $P_5$  found in the juvenile of Fig. 4. In true juveniles (4-segmented

urosomes) the last 2 segments were always fused, whereas they are distinct in the figured juvenile.

The evidence that the figured male described here is the male of *C. magna* is very strong. Ecological evidence: In the samples that yielded the material, 781 cerviniids were found in three stations, all within 10 miles. No other cerviniid was found in these samples, and no other is known to occur in the sample areas (Montagna and Carey, 1978). Males were most abundant in the fall, the only time gravid females were found. Morphological evidence: In my previous (Montagna, 1979) and present study (see discussion of *C. unisetosa*), I came to the conclusion that in the genus *Cervinia* the mouthparts and particularly the mandibular palp (coxa-basis, end., and exp.) and the Mxp basis setation were the most conservative and taxonomically important features in distinguishing the species. The male is consistent with this hypothesis. Though all legs and mouthparts are dimorphic, only the palp of the mandible and setation of the maxilliped are exactly as in the female of *C. magna* (the female is figured in Montagna, 1979).

Given that the male described here is the male of *C. magna*, consistent with the definition of *Cervinia* (Lang, 1948) and inconsistent with the definition of *Pseudocervinia*, *C. magna* is restored its original designation and *Pseudocervinia* is a synonym to *Cervinia*.

### Key to the Species of *Cervinia*

Based on females. *Cervinia brevipes* Brodskaya, 1963, cannot be placed in the key since its swimming leg morphology is unknown; further, it may not be a *Cervinia* at all, since it has no rostrum as do all others in the genus. Consult Table 1 for *C. brevipes* distinguishing characteristics.

1.  $P_2$ – $P_4$  with 2-segmented end.—“*synarthra*” group ..... 2
- $P_2$ – $P_4$  with 3-segmented end.—“*bradyi*” group ..... 5
2.  $P_1$  with 3-segmented end ..... 3
- $P_1$  with 2-segmented end ..... *C. magna* Smirnov
3.  $P_2$ – $P_4$  end. terminal segment with 6, 7, 6 setae and spines respectively ..... 4
- $P_2$ – $P_4$  end. terminal segment with 7, 8, 7 setae and spines respectively ..... *C. langi* Montagna
4. CR with long lateral-proximal seta ..... *C. pilosa* Lang
- CR with short lateral-proximal seta ..... *C. synarthra* Sars
5. CR longer than last urosome segment ( $L/W \geq 5$ ) ..... 6
- CR as long as last urosome segment ( $L/W = 4$ ) ... *C. bradyi* Norman
6. Basis of Mxp twice as long as end. segments;  $P_5$  exp. with 3 seta... 7
- Basis of Mxp as long as 3 end. segments;  $P_5$  exp. with 2 setae ....
- ..... *C. tenuiseta* Brodskaya

Table 1.—Salient morphological characters of the species of *Cervinia* (se. = number of setae, sp. = number of spines, sg. = number of segments).

Species	Endopod setal formulae <sup>1</sup>					CR			Md			Mxp basis <sup>5</sup>
	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>	P <sub>5</sub> se.- s <sup>2</sup>	L/W	≥n LUS <sup>3</sup>	Prox- imal <sup>4</sup> setae	Coxa- basis se.- sp.	Exo- pod sg.- se.		
<i>bradyi</i>												
Norman	1.1.221	1.2.221	1.2.321	1.2.221	3-e	4	1	S	—	—	—	
<i>brevipes</i>												
Broetskaya	1.1.221	—	—	—	3-e	7	2	A	1-2	4-4?	1.1.0	
<i>langi</i>												
Montagna	1.1.221	1.421	1.521	1.421	3-e	6	2	S	1-3	3-5	1.2.1	
<i>magna</i>												
Smirnov	1.321	1.421	1.421	1.221	3-e	4	1	L	2-2	3-5	0.1.0	
<i>pilosa</i>												
Lang	1.1.221	1.321	1.421	1.321	3-e	7	2	L	—	—	—	
<i>synarthra</i>												
Sars	1.1.221	1.321	1.421	1.321	3-e	7	2	S	3-0	2-7	1.1.1	
<i>tenuicauda</i>												
Broetskaya	1.1.221	1.2.221	1.2.321	1.2.221	3-r	18	3.5	A?	2-1	4-4	1.1.0	
<i>tenuiset</i>												
Broetskaya	1.1.221	1.2.221	1.2.321	1.2.221	2-e	12.5	4	L	4-0	4-6	1.2.1	
<i>unisetosa</i>												
n. sp.	1.1.221	1.2.221	1.2.321	1.2.221	3-r	8	2.5	S	1-0	4-5	1.0.0	

<sup>1</sup> For all species exp. formula is P<sub>1</sub> = 1.1.123, P<sub>2</sub>–P<sub>4</sub> = 1.1.223.  
<sup>2</sup> s = shape, either reduced (r) or elongate (e).  
<sup>3</sup> ≥n LUS = as long as or longer than n Last Urosome Segments.  
<sup>4</sup> L, S, A = long, short, or absent; short includes reduced.  
<sup>5</sup> n.n.n. = number of se. associated with (inner, middle, outer) claws, respectively.

7. CR as long as last 4 urosome segments (L/W = 12) .....  
..... *C. tenuicauda* Broetskaya  
– CR as long as last 2 urosome segments (L/W = 8) .....  
..... *C. unisetosa*, n. sp.

*Expansicervinia*, new genus

The genus *Expansicervinia* is proposed for *E. glaciera*, and definition preliminary, based on the type species described herein. The genus has two features which are unique in all the described Cerviniidae. (1) The ventral expansion of the second metasomal segment (Fig. 5), with an associated broadening of the entire P<sub>2</sub> end. (2) An outer knoblike expansion on the first

A<sub>1</sub> segment. The genus belongs to the subfamily Cerviniinae (by virtue of the divergent CR) and is unique in the subfamily by having only 2 outer spines on the terminal P<sub>2</sub>–P<sub>4</sub> exopodites, no rostrum, and an 8-segmented A<sub>1</sub>. P<sub>5</sub> is minute and laterally located; there is an outer expansion of the basis and a very long outer seta.

*Expansicervinia glaciera*, new species

Figs. 5–6

*Cervinia* sp. A Montagna and Carey, 1978:119.

*Material*.—3 ♀♀. Holotype 1 ♀ dissected on slide USNM 180115. Paratype 1 ♀ USNM 180116.

*Type-locality*.—Deep-sea floor off the Arctic coast of Alaska, USA, described as station 49 (72°58'N, 146°29'W, 3,576 m) and station 50 (72°42'N, 143°40'W, 3,386 m) in Montagna and Carey (1978).

*Description*.—Female: Based on nonovigerous ♀ 1.1 mm long (Fig. 5). Body *Cervinia*-like, broadened anteriorly and tapering throughout. R absent. Segment bearing P<sub>1</sub> distinct, segment bearing P<sub>2</sub> ventrally expanded. CR divergent, as long as entire urosome. Lateral excrescences on first 2 urosomal segments (Fig. 5).

A<sub>1</sub> (Fig. 6): 8-segmented, basal segment broadened with outer node. Aesthetasc on segments 3 and 4.

A<sub>2</sub> (Fig. 6): Allobasis with 2 setae. Terminal segment bears 3 inner and 7 terminal setae. Exp. 4-segmented with 2.1.1.3 setae respectively.

Md (Fig. 6): Precoxa with bidentate pars incisiva, tridentate lacina mobilis, and 8 associated spines and a seta. Coxa-basis with 4 long setae. Exp. 4-segmented with 2.1.1.2 setae. End. 1-segmented with 3 inner and 6 terminal setae.

Mxl (Fig. 6): Arthrite with 8 spines, 4 surface setae arranged as opposing pairs. Coxa-basis with 5 inner and 1 outer setae. End. with 10 terminal setae. Exp. represented by 2 setae.

Mx (Fig. 6): Syncoxa with 4 endites, with 5.3.3.2 setae respectively. Basis with 2 claws, 3 setae. End. 2-segmented with 2.4 setae respectively.

Mxp (Fig. 6): Not prehensile. Basis as long as remaining segments, with 3 claws and 1.2.1 setae. 3 end. segments with 1 claw, 1 seta; 3 setae; 2 claws, 2 setae.

P<sub>1</sub>–P<sub>4</sub> (Fig. 5): All rami 3-segmented as figured, setation also listed below:

	<i>Exopod</i>	<i>Endopod</i>
P <sub>1</sub>	1.1.023	1.1.121
P <sub>2</sub>	1.1.222	1.2.221
P <sub>3</sub>	1.1.222	1.2.221
P <sub>4</sub>	1.1.222	1.1.121

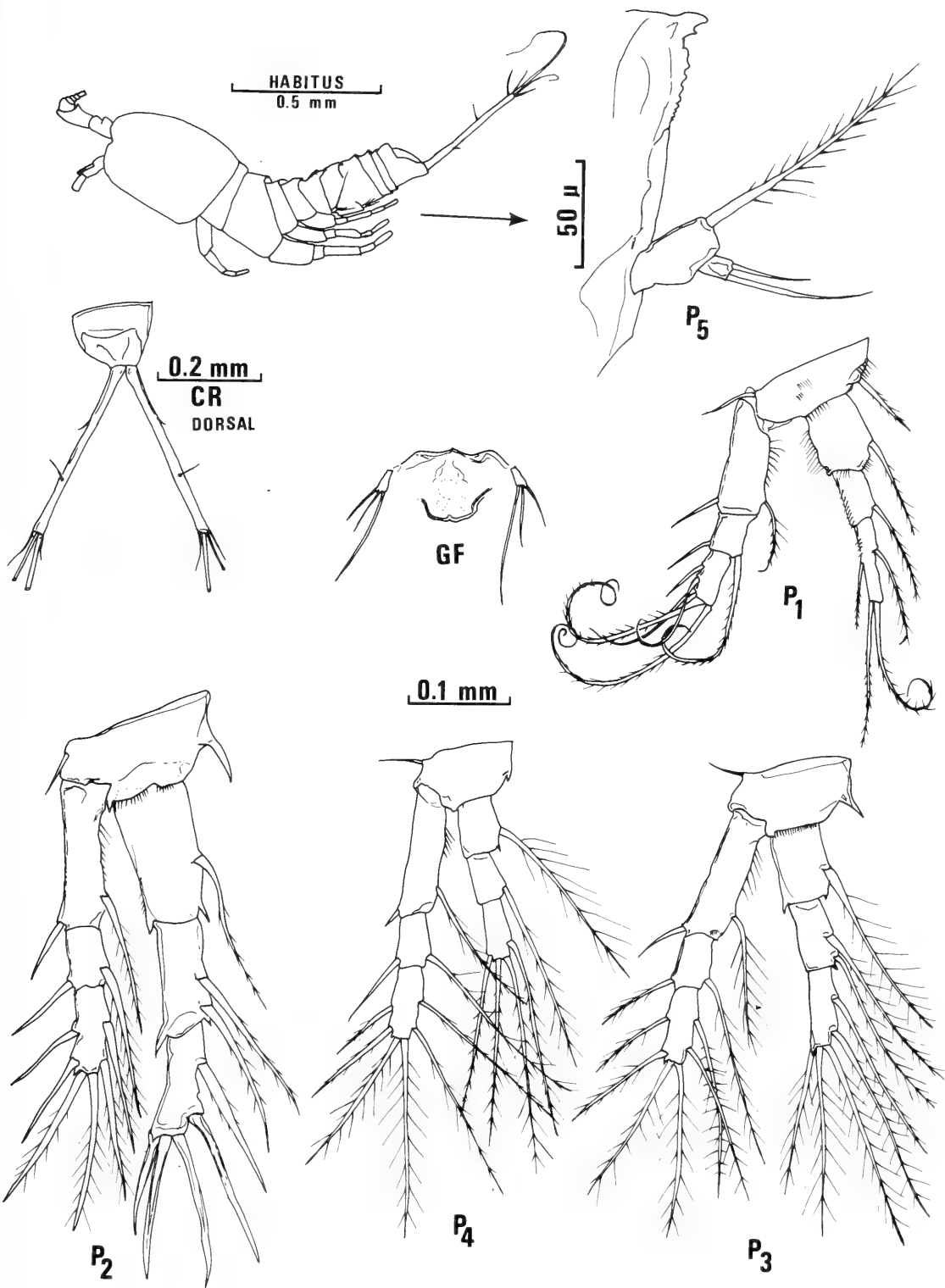


Fig. 5. *Expansicervinia glaciera* ♀.

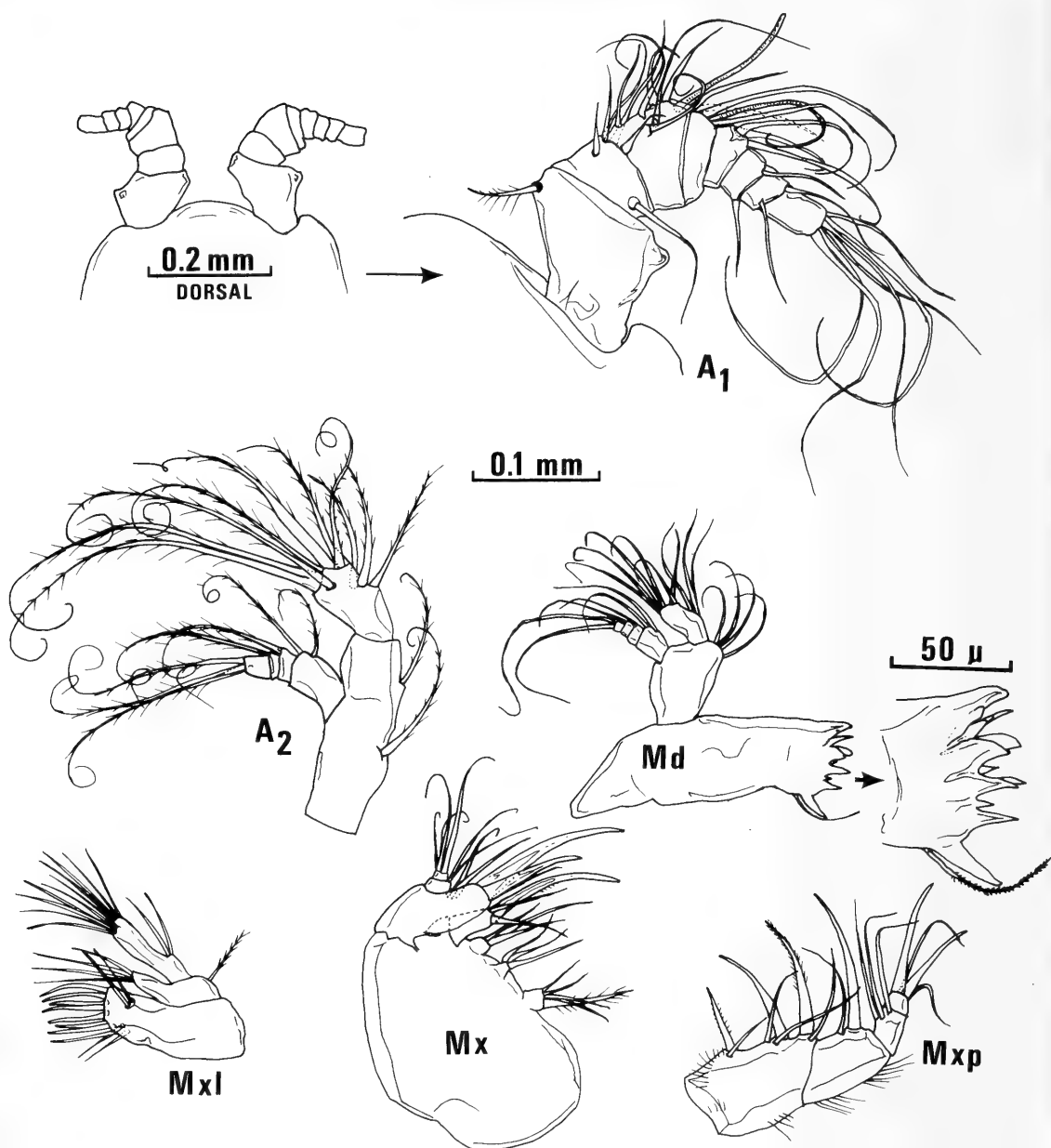


Fig. 6. *Expansicervinia glaciera* ♀.

$P_5$  (Fig. 5): Located laterally (see habitus). No inner expansion of benp., but outer part expanded with 1 long seta. Exp. very small, 2 terminal setae.

$P_6$  & GF (Fig. 5): GF located medio-ventrally, genital pore circular, proximal and distal sclerotized ridges.  $P_6$  lateral to GF with 3 terminal seta.

CR (Fig. 5): L/W = 12, 1 short proximal-lateral seta, 1 middorsal seta, 2 distal setae. Terminally with 2 principal caudal setae.

*Variability*.—None noticed in 3 specimens examined.

*Male*.—Unknown.

*Etymology*.—The generic name *Expansicervinia* (L. 'expansus' = expand) refers to a *Cervinia*-like species with expanded characters; the first segment of the  $A_1$ , the ventral part of the second thoracic segment, and the terminal segment of the  $P_2$  end. The gender is feminine. The specific name *glacieria* is in honor of the USCGC *Glacier*, from which the species was collected, and without which the 4 years of sampling in the Beaufort Sea would not have been possible.

*Discussion*.—*Expansicervinia* most closely resembles *Cervinia* in general body shape,  $P_1$  thoracic segment being distinct, shape and setation of the CR, form and setation of the  $A_2$ , segmentation of the swimming legs, and general form of the mouthparts. Both these genera are distinct from others in the subfamily by these same characteristics; hence they are probably close phylogenetically. However, *Expansicervinia* is distinct from *Cervinia* in that  $A_1$  is 8-segmented with the basal segment enlarged (7 segments in *Cervinia*), R is absent,  $P_1$  lacks an inner seta on the terminal exp.,  $P_2$  segment is ventrally enlarged,  $P_2$ – $P_4$  have only 2 outer spines on terminal exopodites (opposed to 3 in *Cervinia*), and there is an outer expansion of  $P_5$  basis.

The expansion of the  $P_2$  segment is unique in all the Harpacticoida and its function may be peculiar to deep-sea life. Though this character is unknown in other deep-sea harpacticoids, only further research could test this hypothesis. The morphological result of the expansion is that the animal can never straighten; thus the anterior end of the body must always be oblique to the sediment. Lengthened body parts in other harpacticoids usually are associated with epipelagic life; the expanded segment would further lengthen the body and is probably an adaption toward this existence. Associated with the second segment is the peculiar shape of the  $P_2$  endopod, which is much longer than the exopod, outwardly broadened, and possesses broad, thick spines. Thus the entire second segment is specialized, perhaps for some form of epipelagic existence in the deep-sea.

Subfamily Cerviniopsinae Brodskaya, 1963

*Ameliotes* Por, 1969

*Stratiopontotes* Soyer, 1970:379.

*Discussion*.—As pointed out by Bodin (1979), the two genera *Ameliotes* and *Stratiopontotes* are very similar to one another. In fact, the generic descriptions are alike. Priority in this case is obfuscated by the publication date of the journal *Vie et Milieu*; though the cover says 1969, it was printed and published in 1970. Following Corliss (1979) I assign priority to Por's description (1969) over Soyer (1970). The latter's species should now be referred to as *Ameliotes mediterraneus* (Soyer, 1970).



## Key to Subfamilies and Genera of Cerviniidae

1. CR divergent ..... subfam. Cerviniinae Brodskaya 2
- CR opposed (parallel) ..... subfam. Cerviniopsinae Brodskaya 6
2. Exp.  $P_1$ – $P_4$  with 3 segments ..... 3
- Exp.  $P_1$ – $P_4$  with 1 or 2 segments ..... *Cerviniella* Smirnov
3. CR at least as long as last urosomal segment;  $A_1$  7–8 segmented .. 4
- CR at most half as long as urosomal segment;  $A_1$  6-segmented ..... *Paracerviniella* Brodskaya
4.  $A_1$  7-segmented; with rostrum ..... 5
- $A_1$  8-segmented; rostrum absent; ventral expansion of segment bearing  $P_2$  ..... *Expansicervinia*, n. gen.
5. CR of equal lengths ..... *Cervinia* Norman
- Right CR longer than left ..... *Eucanuella* T. Scott
6. Prosome segments lacking or with reduced lateral ornamental excrescences ..... 7
- Prosome with lateral or dorsal ornamentation ..... *Pontostratiotes* Brady
7.  $A_1$  8-segmented ..... 8
- $A_1$  6-segmented ..... *Cerviniopsis* Sars
8.  $P_1$  end. 3-segmented without apophysis ..... 9
- $P_1$  end. 2-segmented with apophysis ..... *Hemicervinia* (I. C. Thompson)
9. End. of Mx1 3-segmented ..... *Ameliotes* Por
- End. of Mx1 reduced and fused to basis ... *Herdmaniopsis* Brodskaya

## Acknowledgments

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TWO NEW RECORDS OF THE CARIBBEAN  
MARINE TUBIFICID *KAKETIO INERI*  
RIGHI AND KANNER (OLIGOCHAETA)

Christer Erséus

*Abstract.*—*Kaketio ineri* Righi and Kanner, 1979, originally described from Bonaire in the southern Caribbean Sea, is reported from subtidal sands in Bermuda and southern Florida. The genus *Kaketio* Righi and Kanner, 1979, is supposed to be closely related to *Thalassodrilides* Brinkhurst and Baker, 1979.

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In a recent taxonomic account of some marine oligochaetes from the Caribbean Sea, Righi and Kanner (1979) established a new genus and species of tubificid from Bonaire, *Kaketio ineri*. Two small lots of marine oligochaetes from Bermuda and Florida, received for identification by me, proved to belong to this species. The four worms, two from each area, were stained in paracarmine and mounted whole in Canada balsam. The genital region of one of the specimens from Florida was cut into two halves before mounting. Although being scanty, the new material adds valuable information as to the geographical distribution of *K. ineri*.

*Kaketio ineri* Righi and Kanner, 1979

*Kaketio ineri* Righi and Kanner, 1979:55-62, figs. 39-47.

*Type-material and type-locality.*—See Righi and Kanner (1979).

*Material examined.*—United States National Museum of Natural History Cat. No. 60130, 2 specimens from Whale-Bone Bay, Bermuda, subtidal sand, shallow water, coll. 14 Aug. 1975, by M. L. Jones; USNM 60131, 2 specimens from Buttonwood Sound, Key Largo (Monroe Co.), S of Miami, Florida, muddy sand with algae, 1-2 m depth, coll. May 1977, by R. Rehrer (University of Miami).

*Remarks.*—*K. ineri* was very carefully described and depicted by Righi and Kanner (1979). My new specimens conform well to their description in all fundamental characters, although the two specimens from Bermuda are only partially mature. The single specimen (from Florida) that is fully grown posteriorly is 15.5 mm long and consists of 74 segments. This is slightly different from the only complete specimen examined by Righi and Kanner (25 mm, 52 segments).

One of the spermathecae in one of the worms from Florida contains the

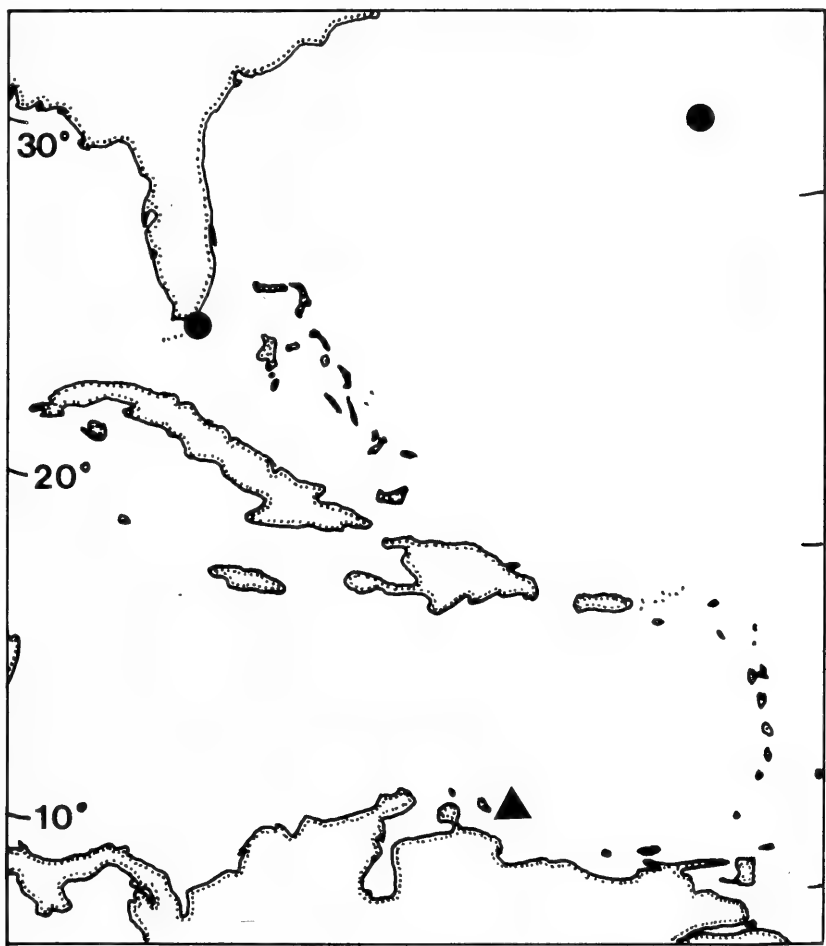


Fig. 1. Map of the Caribbean area showing geographical records of *Kaketio ineri* Righi and Kanner. Triangle = type-locality; circles = new records.

strange hyaline structure with 6 pairs of denticles which was described by Righi and Kanner (cf. their fig. 46).

*Habitat*.—Marine shallow-water, muddy sands.

*Geographical distribution*.—Known from Bermuda, Florida (new records) and Bonaire (Fig. 1).

*Discussion*.—The new material extends the known geographical distribution of *K. ineri* (Fig. 1); it can be expected to occur throughout the Caribbean.

According to Righi and Kanner, the male efferent ducts of *Kaketio*, superficially at least, resemble those of *Aulodrilus* Bretscher, 1899. However, in my opinion, *Kaketio* appears more closely related to *Thalassodrilides* Brinkhurst and Baker, 1979. [Synonym: *Curacaodrilus* Righi and Kanner, 1979. This genus name was published the same year as *Thalassodrilides*, but the publication was distributed later than that of Brinkhurst and Baker.]. Both *Kaketio* and *Thalassodrilides* are characterized by their possession of

relatively wide vasa deferentia entering more or less cylindrical atria, which bear discrete, but not stalked, prostate glands, and which terminate into glandular atrial ducts before ending in folded, eversible pseudopenes that are enclosed in large muscular sacs. It was not mentioned in the original definition of *Thalassodrilides*, but all species of that genus have a barrel-shaped, thick-walled and dilated, portion of the intestine with a plexus of fine blood vessels in segment IX (Erséus, in preparation; cf. Righi and Kanner, 1979:54). This occurs also in *K. ineri* (cf. Righi and Kanner, 1979:57), but is otherwise not common in the Tubificidae. The principal distinguishing characters of the two genera are found in the morphology of their atria. In *Kaketio*, each atrium is divided into two parallel structures: a proper atrium, which is thin-walled and narrow, and a glandular and compact body (termed "atrial diverticulum" by Righi and Kanner), which covers the ventrolateral surface of the proper atrium, and to the full length of which the prostate glands are attached. In *Thalassodrilides*, this "diverticulum" is absent, and the attachment of the prostates is not as broad as in *Kaketio*.

#### Acknowledgments

Dr. M. L. Jones (Smithsonian Institution, Washington, D.C.) and Dr. G. H. Darcy (NOAA, National Marine Fisheries Service, Miami, Florida) kindly provided me with the material.

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# A NEW SPECIES OF THE MARINE AMPHIPOD GENUS *GAMMAROPSIS* FROM THE SOUTHEASTERN UNITED STATES (PHOTIDAE)<sup>1</sup>

Walter G. Nelson

*Abstract.*—A new species of the amphipod genus *Gammaropsis*, *G. sutherlandi*, encountered during ecological studies of the amphipods of the estuaries of North Carolina, is described here. The new species appears closely related to *Gammaropsis maculata* (Johnston) 1827.

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During ecological investigations of the amphipod crustaceans associated with beds of eelgrass (*Zostera marina*) in the sounds near Beaufort, N.C. (Nelson, 1979a, b), specimens of the marine photid genus *Gammaropsis* were collected. The material proved to be a species new to science and constitutes an addition to the list of amphipod species found in the shallow estuarine waters of North Carolina (Fox and Bynum, 1975; Bynum and Fox, 1977; Nelson, 1979c) as well as to the amphipod fauna of the southeastern United States.

*Gammaropsis sutherlandi*, new species

Figs. 1-3

*Eurystheus maculatus*.—Pearse and Williams, 1951.

*Eurystheus erythophthalmus*.—Pearse and Williams, 1951.

*Eurystheus maculatus*.—McClosky, 1970?

*Gammaropsis maculata*.—Fox and Bynum, 1975?

*Gammaropsis maculata*.—Fox, 1978?

*Description.*—*Male.*—8.5 mm. Eye oval, on acutely rounded produced cephalic lobes. Head equals width of 1.5 pereonites. Antenna 1, 42% of total body length, 103% of antenna 2; ratio of articles 1:2:3—1:1.4:.93, ventral margin with long setae; flagellum with 16 articles, 92% of peduncle length; accessory flagellum with 7 articles. Antenna 2, 41% of total body length, ratio of articles 3:4:5—1:2.4:2.2; flagellum 57% of peduncle length, with 13 articles.

Gnathopod 1, article 2 with posterodistal group of setae. Gnathopod 2, ratio of articles 5:6—1:1.7; article 2 with a few medium setae on anterior

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<sup>1</sup> Contribution from Harbor Branch Foundation, Inc.

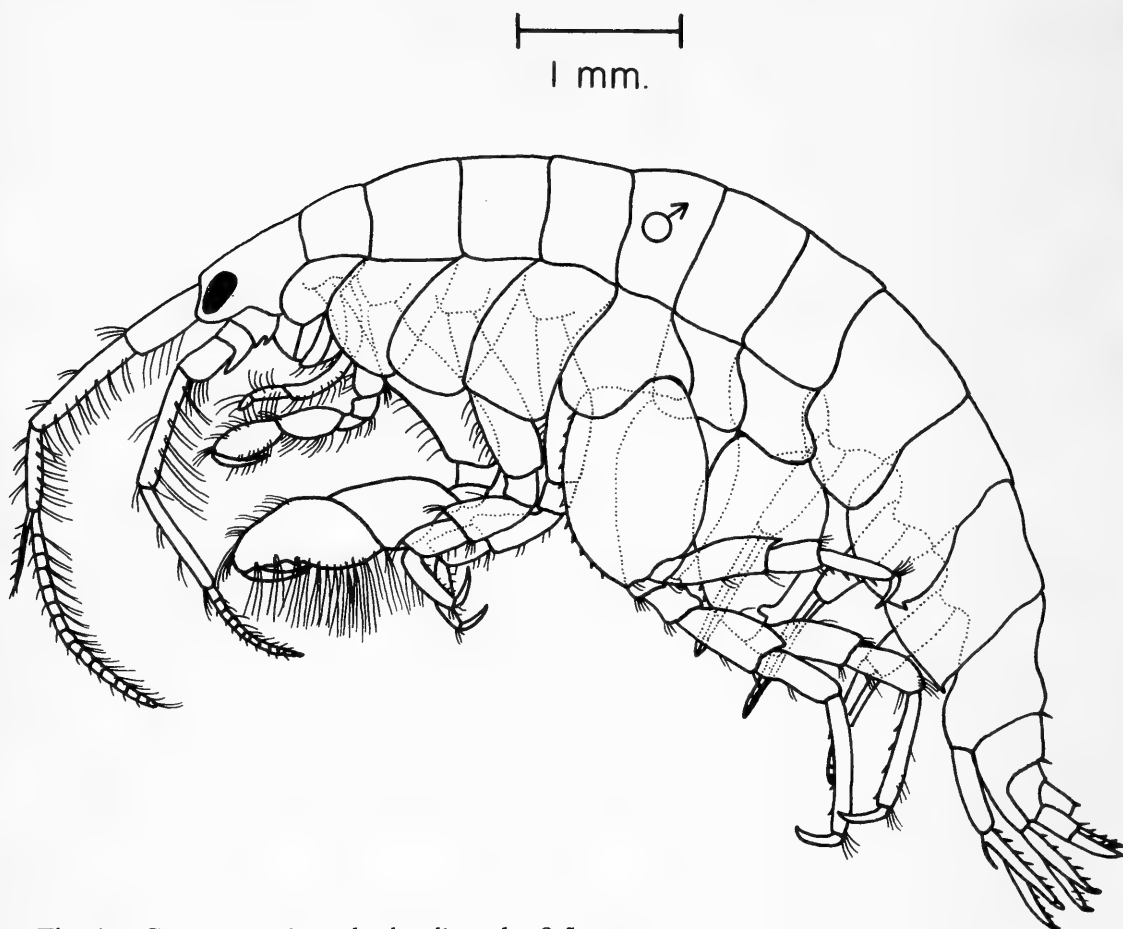


Fig. 1. *Gammaropsis sutherlandi*, male, 8.5 mm.

edge; article 5 with 9–10 clusters of setae on posterior margin; article 6 with 7 clusters of setae on posterior margin behind palm and 7 clusters on palm, 4 rows of setae on anterior margin, palm not defined by angular projection, smooth curve from hind margin into concave palm, 2 small teeth projecting from curve of palm dividing palm roughly into thirds; setae on articles 5 and 6 longer than width of article 6.

Epimeron 2 with small tooth on posterodistal corner. Epimeron 3 with strong tooth on posterodistal corner.

Uropod 1, peduncle with distoventral edge produced into upturned spur  $\frac{1}{3}$  length of rami; inner ramus slightly longer than outer; peduncle equal to outer ramus in length, outer margin with 8 spines, inner margin with 9 small spines and 1 large distal spine; outer ramus with 6 outer and 4 inner marginal spines; inner ramus with 7 outer and 3 inner marginal spines. Uropod 2, peduncle with 3 spines on outer margin, 1 distal spine on inner margin; inner ramus longer than outer; outer ramus equals length of peduncle; outer ramus with 5 outer and 4 inner marginal spines; inner ramus with 6 outer and 3

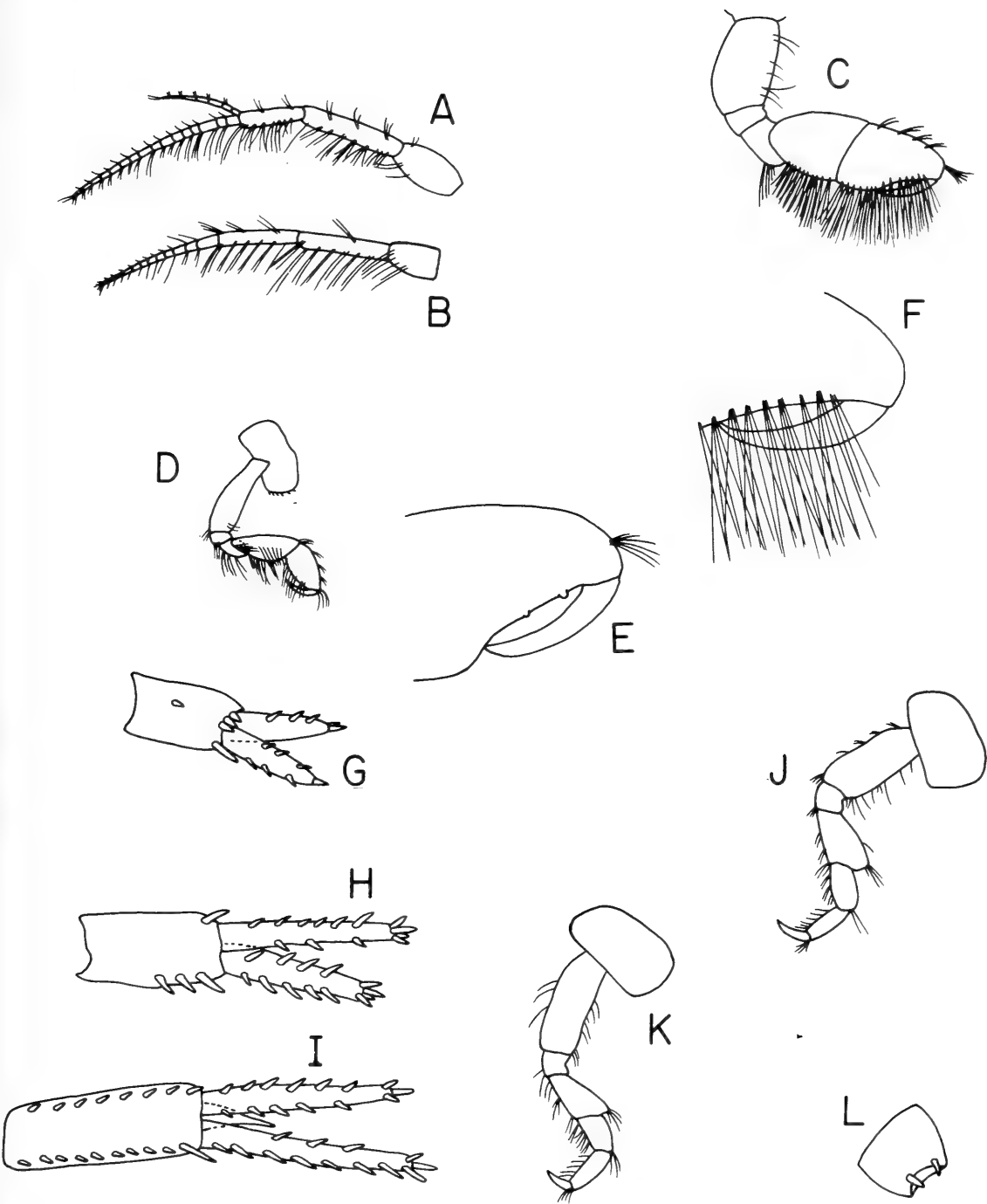


Fig. 2. *Gammaropsis sutherlandi*, male, 8.5 mm: A, Antenna 1; B, Antenna 2; C, Gnathopod 2; D, Gnathopod 1; E, Detail of palm, gnathopod 2, setae removed; F, Detail of palm, gnathopod 2, setae present; G, Uropod 3; H, Uropod 2; I, Uropod 1; J, Pereopod 3; K, Pereopod 4; L, Telson.



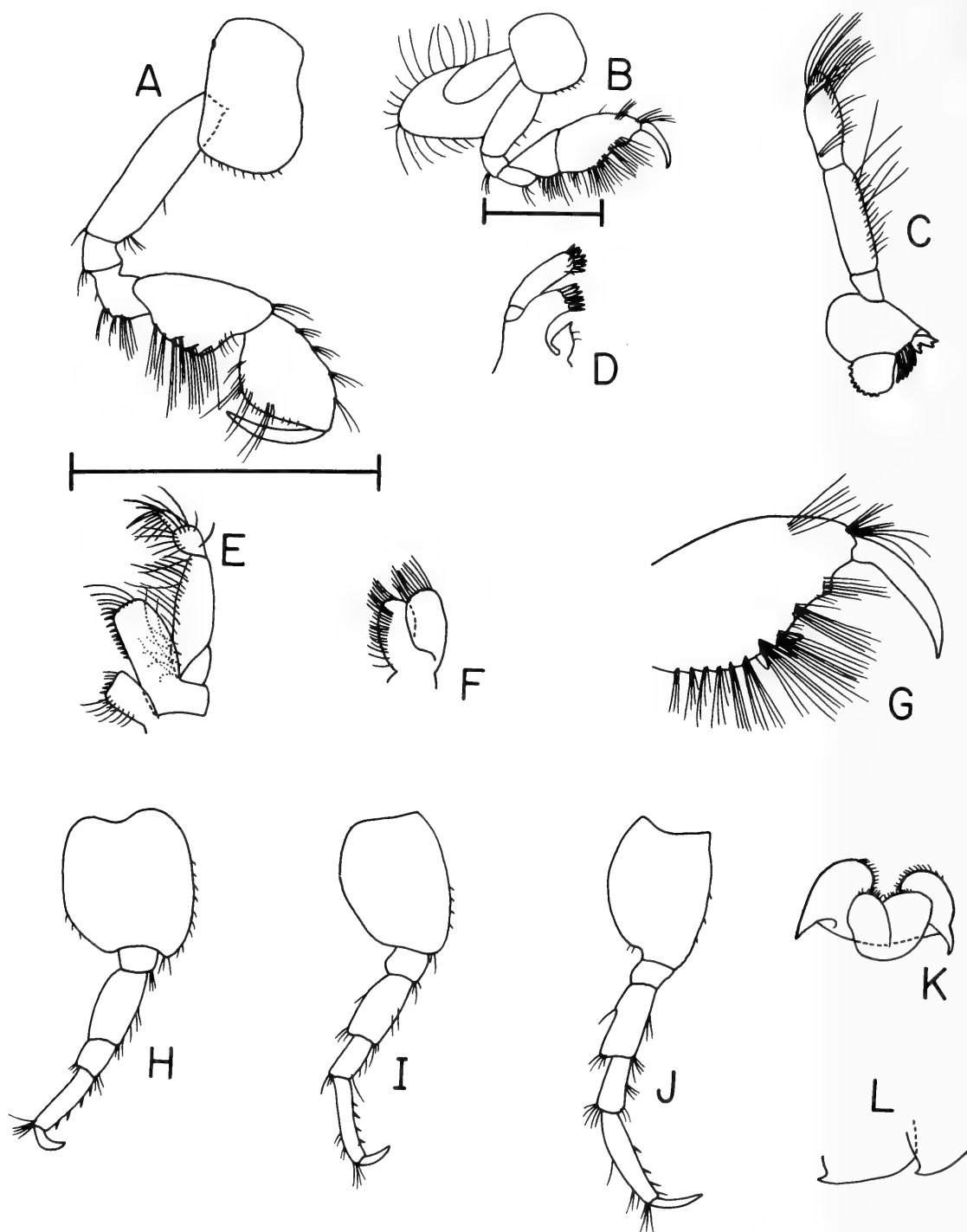


Fig. 3. *Gammaropsis sutherlandi*, female, 8.5 mm: A, Gnathopod 1, scale = 1 mm; B, Gnathopod 2, scale = 1 mm; C, Mandible; D, Maxilla 1; E, Maxilliped; F, Maxilla 2; G, Detail of palm, gnathopod 2; H, Pereopod 5; I, Pereopod 6; J, Pereopod 7; K, Lower lip, male 8.5 mm; L, Epimera 2 and 3.

inner marginal spines. Uropod 3, peduncle with 1 small dorsomedial spine and 3 flattened dorsomedial spines at junction with rami, 1 large distal spine on inner margin; outer ramus with 3 outer and 0 inner marginal spines; inner ramus with 3 inner and 3 outer marginal spines. Telson moderately incised with stout medial spines.

*Female*.—8.5 mm. Gnathopod 1, like male except article 5 lacks medial line of setae. Gnathopod 2, much less massive than in male; article 2 with a few setae on anterior margin; article 6, 2 times length of article 5, palm oblique with 2 small acute projections and 1 spine inserted medially near first projection, palm defined only by presence of second spine—not by an angular projection.

*Material examined*.—Types: Holotype male, 7.7 mm, Frying Pan Shoal, 5 Mar. 1935, USNM 173231. Allotype female, 6.7 mm, Frying Pan Shoal, 5 Mar. 1935, USNM 173232. Paratype series, Beaufort, N.C., USNM 173233, including paratype male, 8.5 mm, and paratype female, 8.5 mm, figured herein. Duke University Marine Laboratory, Beaufort, N.C. from fouling tiles, 14 Apr. 1974, 1 ovigerous female, 1 immature; 19 Mar. 1975, 2 females, 1 male; 20 May 1975, 1 female, 1 immature. Shackleford Jetty, Bogue Sound, N.C. from algae, 20 Jan. 1976, 1 ovigerous female; 17 Mar. 1976, 1 male, 1 immature. Material from Duke University Marine Laboratory Reference Museum collections, from dredge samples collected by R.V. *Eastward* off the coast of N.C., 19 Apr. 1965, 1 female, 34°34.5'N, 76°25.5'W, 20 m; *Eastward* station 17069, 1 male, 2 females; *Eastward* station 3645, 13 Jan. 1966, 1 male.

Material from USNM collections: From North Carolina.—Off Bogue Inlet, 19 July 1915, 2 females, 2 immatures, No. 8286; Shackleford Banks, 12 Sept. 1928, 5 females, USNM 102997; Frying Pan Shoal, 5 Mar. 1935, 2 males, 5 females, 1 immature, USNM 133318; Frying Pan Shoal, 2 Apr. 1935, 1 ovigerous female, USNM 134066; Black Rocks off New River, 19 June 1949, 4 males, 5 females, USNM 183351; Black Rocks off New River, 19 June 1949, 1 female, USNM 183864. From South Carolina.—*Albatross* Sta. 20037, 12 Dec. 1919, 1 ovigerous female, USNM 64746; east of Cape Romain, 1 July 1935, 3 females, USNM 135202; off Little River Inlet, 17 Aug. 1949, 3 males, 2 females, USNM 183864. From Dry Tortugas, Florida.—Tortugas, 1 female, Sta. No. 33-31; south of Tortugas, 31 July 1930, 1 male, 11 females, Sta. No. 38-30; south of Tortugas, 23 July 1932, 1 male, Sta. No. 59-32; Tortugas (Haul 210 by W. L. Schmitt), 10 June 1925, (2 lots) 1 female and 1 male, 2 females and 3 immatures, USNM 93400; Loggerhead Key, 7 Aug. 1931, 5 males, 3 females, 3 immatures, USNM 115488; Miscellaneous, probably Tortugas, 17 June 1932, 2 ovigerous females, Sta. No. 3-32; south of Tortugas, 4 Aug. 1931, 1 female; *Fish Hawk* Sta. No. 8499, 5 males, 19 females; *Fish Hawk* Sta. No. 8895, 1 ovigerous female.

*Distribution*.—Cape Hatteras, south side, south to the Dry Tortugas of Florida, in depths from shallow subtidal to 300 m.

*Relationships*.—*Gammaropsis sutherlandi* appears to be closely related to *Gammaropsis maculata* (Johnston) 1827 but is distinct from it in several features. The comparisons below are based on *G. maculata* (= *G. erythopthalma* figured by Sars, 1894, pl. 198) material from Norway in the collection of the Zoological Museum of the University of Oslo. The confused synonymy of *G. maculata* has been discussed by Krapp-Schickel and Myers (1979). The flagellum of antenna 1 is equal to 70–80% of the length of the peduncle in *G. maculata* and 92% in *G. sutherlandi*, with the flagellum being composed of 13–14 articles in males of *G. maculata* and 16–18 in *G. sutherlandi*.

The posterodistal corner of article 2 of gnathopod 1 possesses a group of setae in males of *G. sutherlandi* and lacks it in *G. maculata*. On gnathopod 2, setae are found on the anterior margin of article 2 of both males and females of *G. sutherlandi* and are lacking in *G. maculata*. Article 5 of male gnathopod 2 possesses 6 groups of setae in *G. maculata* and 9–10 in *G. sutherlandi*. Article 6 of male gnathopod 2 possesses 9 groups of setae on the posterior margin in *G. maculata* and 14 in *G. sutherlandi*. The palm of male gnathopod 2 is defined by a small distally pointing angular projection in *G. maculata* and is not defined by any angular projection in *G. sutherlandi*. The setae on articles 5 and 6 of male gnathopod 2 are less than the width of article 6 in *G. maculata* and equal to or greater than the width of article 6 in *G. sutherlandi*. Both species possess 2 toothlike projections on the palm. Although the degree of development of these teeth varies in *G. sutherlandi*, maximum development is considerably less than that for *G. maculata*, although Krapp-Schickel and Myers (1979) suggest the palmar teeth of *G. maculata* become obsolete in old males.

*Etymology*.—This species is named for Dr. John P. Sutherland in honor of his contributions to the study of marine fouling communities and the field of marine ecology.

*Ecology*.—This species appears quite generalized in its epifaunal habitat. It has been collected from the shallow subtidal from algae on rock jetties, from the fouling community, and rarely, from eelgrass (*Zostera marina*) beds in the estuary near Beaufort, N.C. It has also been collected from such substrates as stones, the backs of spider crabs, ceramic fouling plates, and was also common in the stomach contents of sea bass taken from approximately 15 m depth on an artificial reef structure off Wilmington, N.C. In the region of Beaufort, N.C. available data indicate a breeding season of from at least January through July, and this species may well breed year round.

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## CESTODE PARASITES OF SOME VENEZUELAN STINGRAYS

Monte A. Mayes and Daniel R. Brooks

**Abstract.**—Forty-seven stingrays representing 8 species collected in Venezuelan coastal waters were examined for cestode parasites. Specimens of 18 tetraphyllidean, lecanicephalidean, and trypanorhynchan cestode species were collected, 3 described as new. *Rhinebothrium margaritense* sp. n. from *Dasyatis guttata* and *D. americana* most closely resembles *R. spinicephalum* and *R. tetralobatum* but differs by having 3-6 rather than only 2 testes per proglottid and a different number of bothridial loculi. *Rhodobothrium paucitesticulare* sp. n. from *Rhinoptera bonasus* possesses fewer than half as many testes per proglottid as any other known member of the genus. *Dioecotaenia campbelli* sp. n. differs from *D. cancellata* by having 24 rather than 21 bothridial loculi and smaller eggs and embryos. Other collected species include: *Acanthobothrium electricolum* in *Narcine brasiliensis*, *A. fogeli* in *Gymnura micrura*, *Disculiceps* sp. and *Acanthobothrium tortum* in *Aetobatus narinari*, *Tylocephalum* sp. and *Rhinoptericola megacantha* in *Rhinoptera bonasus*, *Rhinebothrium magniphallum* and *Parachristianella* cf. *monomegacantha* in *Himantura schmardae*, *Acanthobothrium americanum*, *Phyllobothrium centrurum*. *Rhinebothrium corymbum* and *Rhodobothrium pulvinatum* in *Dasyatis americana*, and *Acanthobothroides thorsoni*, *Acanthobothrium tasajerasi*, *A. urotrygoni*, *Rhinebothrium magniphallum*, and *Rhodobothrium pulvinatum* in *Dasyatis guttata*. All represent new locality records, and those species occurring in *Dasyatis guttata* are reported from that host for the first time.

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Little is known about the helminth fauna of elasmobranchs living along the Venezuelan coast. Troncy (1969) described a nematode, *Echinocephalus diazi*, from Lake Maracaibo and listed the freshwater stingray *Potamotrygon hystrix* as host. Later, Diaz-Ungria (1973) corrected the host identification to the euryhaline dasyatid stingray *Himantura schmardae* (Werner). Deardorff, Brooks, and Thorson (in press) discovered *E. diazi* in *H. schmardae* from Colombia, thus confirming Diaz-Ungria's statement. We found no other reports of helminths infecting Venezuelan coastal stingrays.

This paper reports 18 species of tetraphyllidean, lecanicephalidean and trypanorhynchan cestodes collected by the first author during examinations of 47 stingrays representing 8 species. Stingrays were collected during the summer from the Gulf of Venezuela and from Lake Maracaibo (1977 and 1978) and from Isla de Margarita (1978). Table 1 summarizes our findings.

Helminths were removed from hosts, examined alive when possible, fixed with AFA or 10% formalin and stored in 70% ethanol. Most specimens were stained with Mayer's hematoxylin and mounted in Canada balsam for study as whole mounts. Serial cross sections, cut at 8  $\mu\text{m}$  and stained with hematoxylin-eosin, were used to confirm some aspects of proglottid morphology. All measurements are in  $\mu\text{m}$  unless otherwise stated; figures were drawn with the aid of a drawing tube. Representative specimens of all species have been deposited in the University of Nebraska State Museum, Division of Parasitology, Harold W. Manter Laboratory.

*Rhinebothrium margaritense*, sp. nov.

Figs. 1–2

*Description* (based on 15 specimens).—Strobila up to 5.7 mm long, craspedote, apolytic, composed of 75–100 proglottids. Scolex up to 1.86 mm wide, composed of 4 pedicellated, elongate, bilobed, septate bothridia. Bothridia 744–1,209 long by 232–279 wide; divided longitudinally by median septum, horizontally by hingelike constriction between lobes; posterior lobe divided horizontally by 12–13 septa forming 26–28 loculi; anterior lobe divided horizontally by 12 septa forming 26 loculi plus terminal loculus at tip; total number of loculi per bothridium 53 or 55. Pedicels 418–558 long. Cephalic peduncle short, aspinose, 46–93 long. Immature proglottids wider than long. Mature proglottids 120–456 long by 182–240 wide, length greater than width only in last 6–10 proglottids if at all. Genital pore 48–52% ( $\bar{x}$  = 50%,  $n$  = 50) of proglottid length from anterior end. Testes 3–6 ( $\bar{x}$  = 4,  $n$  = 68) in number, 20–60 in diameter. Cirrus sac elongate, 84–120 long by 36–72 wide, containing spined eversible cirrus. Genital atrium shallow, simple. Vagina anterior to cirrus sac, sphincter present. Ovary X-shaped in cross section, bilobed in frontal view, lobate, poral lobe extending anteriorly to level of genital pore; 65–156 long by 50–165 wide at isthmus. Vitellaria follicular; follicles 3–7 in diameter, extending nearly entire length of proglottid. Gravid proglottids not collected.

*Hosts*.—*Dasyatis guttata* (Bloch and Schneider) (type); *Dasyatis americana* Hildebrand and Schroeder.

*Site of infection*.—Spiral valve.

*Locality*.—Isla de Margarita, near Robledal, Venezuela.

*Holotype*.—USNM Helm. Coll. No. 75715. Paratypes: USNM Helm. Coll. No. 75716; Univ. Nebraska State Museum No. 21036.

*Etymology*.—This species is named for the island from which it was collected.

*Remarks*.—*Rhinebothrium margaritense* is a member of a monophyletic species-group within *Rhinebothrium* characterized by being small worms with relatively to markedly long bothridial pedicels, more than 25 proglottids

Table 1.—Host-parasite list for cestodes collected in Venezuelan coastal waters during 1978 and 1979. All previously known species are reported from Venezuela for the first time. \* = new host record.

Host	Cestode species	Locality and incidence
<i>Narcine brasiliensis</i> (Olfers)	<i>Acanthobothrium electricolum</i> Brooks and Mayes, 1978	Robledal, Isla de Margarita (1/3)
<i>Rhinobatos percellens</i> (Walbaum)	Negative	Isla de Margarita (2)
<i>Aetobatus narinari</i> (Euphrasen)	<i>Acanthobothrium tortum</i> Linton, 1890 <i>Disculiceps</i> sp.	Gulf of Venezuela, Caimaré Chico (1/1) same
<i>Gymnura micrura</i> (Bloch and Schneider)	<i>Acanthobothrium fogeli</i> Goldstein, 1964	Isla de Margarita (1/2)
<i>Rhinoptera bonasus</i> (Mitchill)	<i>Rhinoptericola megacantha</i> Campbell and Carvajal, 1975 <i>Rhodobothrium paucitesticulare</i> sp. n. <i>Dioecotaenia campbelli</i> sp. n. <i>Tylocephalum</i> sp.	Gulf of Venezuela, Caimaré Chico (1/9) same same same
<i>Himantura schmardae</i> (Werner)	<i>Parachristianella</i> cf. <i>monomegacantha</i> <i>Rhinebothrium magniphallum</i> Brooks, 1977	Boca Cañonero, Bahía de Tablazo, Lake Maracaibo (1/2) same
<i>Dasyatis americana</i> Hildebrand and Schroeder	<i>Phyllobothrium centrurum</i> Southwell, 1925 <i>Rhodobothrium pulvinatum</i> Linton, 1889 <i>Rhinebothrium corymbum</i> Campbell, 1975 <i>Rhinebothrium margaritense</i> sp. n. <i>Acanthobothrium americanum</i> Campbell, 1969	Isla de Margarita (3/3) same (2/3) same (1/3) same (2/3) same (2/3)
<i>Dasyatis guttata</i> (Bloch and Schneider)	<i>Rhodobothrium pulvinatum</i> * Linton, 1889 <i>Rhinebothrium magniphallum</i> * <i>Rhinebothrium margaritense</i> sp. n.	Gueria, Gulf of Paria (1/3) Mouth of Lake Maracaibo (1/9) El Guano, S. of Rio Apon, Lake Maracaibo (1/5) Robledal, Isla de Margarita (1/2)

Table 1.—Continued.

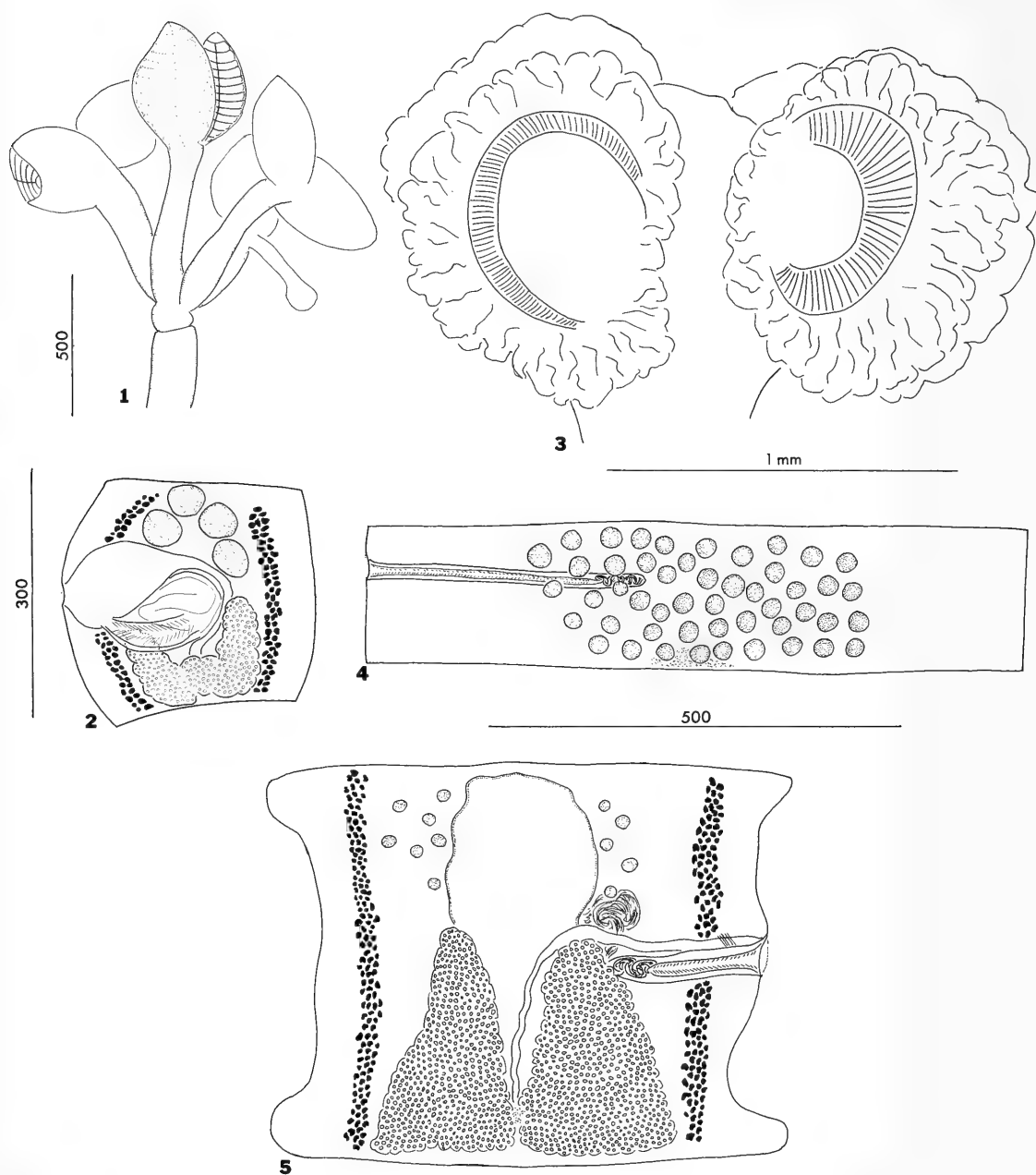
Host	Cestode species	Locality and incidence
	<i>Acanthobothroides thorsoni</i> * Brooks, 1977	Robledal, Isla de Margarita (1/2)
	<i>Acanthobothrium urotrygoni</i> * Brooks and Mayes, 1980	Gulf of Venezuela, Caimaré Chico (1/5) Mouth of Lake Maracaibo (1/9) Robledal, Isla de Margarita (1/2)
	<i>Acanthobothrium tasajerasi</i> Brooks, 1977	Mouth of Lake Maracaibo (1/9)

per strobila, craspedote proglottids which are wider than long except for terminal proglottids, bilobed bothridia with a single median septum and at least 32 loculi, and an average of fewer than 10 testes per proglottid. The genealogical relationships of that species-group's members have been presented elsewhere (Brooks, Mayes, and Thorson, in press). The new species most closely resembles *R. spinicephalum* Campbell, 1969 and *R. tetralobatum* Brooks, 1977 both of which possess 2 testes per proglottid rather than 3–6 ( $\bar{x}$  = 4) exhibited by *R. margaritense*. *Rhinebothrium spinicephalum* further differs from the new species by possessing 32–34 bothridial loculi rather than 53 or 55 as exhibited by *R. margaritense*; *R. tetralobatum* possesses 48–54 loculi. Both *R. spinicephalum* and *R. margaritense* possess compact lobate ovaries, differing from the fragmented 4-part ovaries of specimens of *R. tetralobatum*.

*Rhodobothrium paucitesticulare*, sp. nov.  
Figs. 3–5

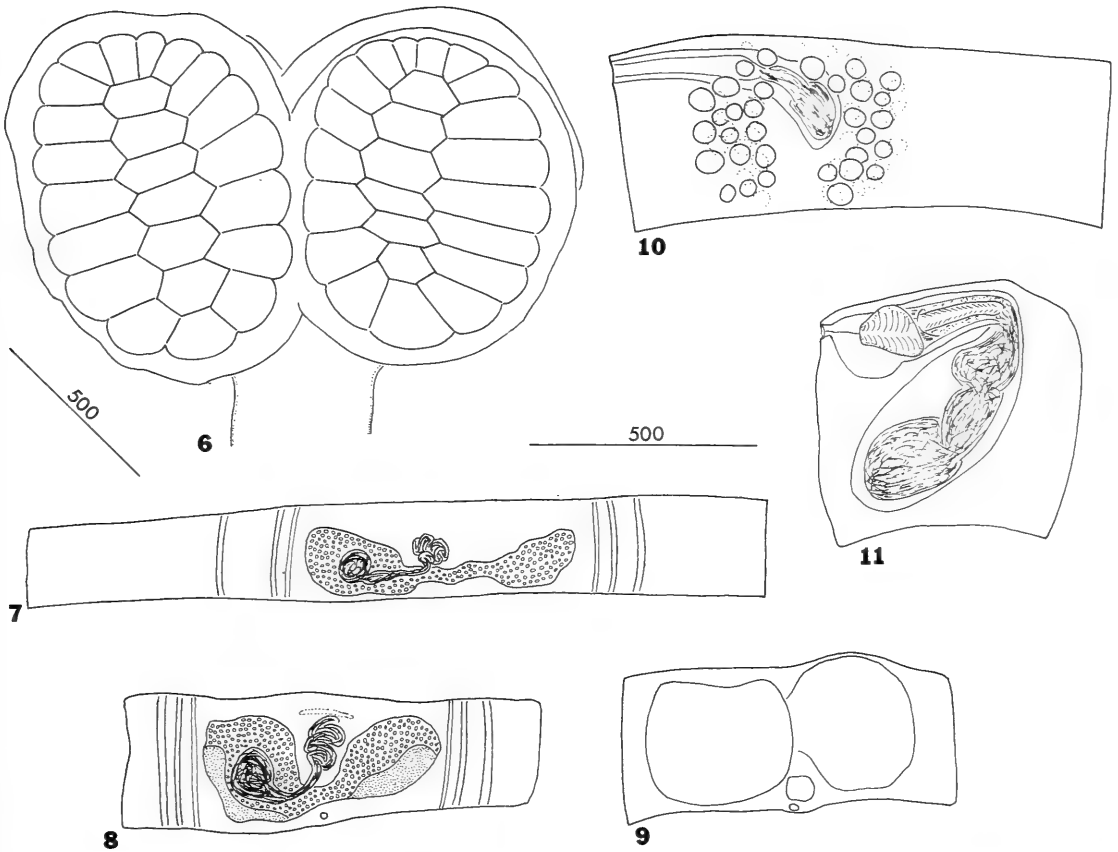
*Description* (based on 7 specimens).—Tetraphyllidea, Phyllobothriidae, *Rhodobothrium* Linton, 1890 as emended by Campbell and Carvajal, 1979. Strobila craspedote, serrate posteriorly, maximum dimensions 20–31 mm long by 7.4–9.0 mm wide. Scolex 1.0–1.9 mm wide, composed of 4 pedicellated bothridia. Bothridia 465–930 long by 465–930 wide, trumpet-shaped when relaxed, adherent surfaces convex, traversed by numerous convolutions forming irregular pattern. Bothridial faces round or subtriangular in cross section, margins ruffled. Pedicels approximately 250 long. Neck up to 1.86 mm long by 700 wide. Number of segments 400–600. Immature proglottids wider than long, markedly protandric. Mature proglottids squared,





Figs. 1-5. *Rhinebothrium margaritense*: 1, Scolex; 2, Mature proglottid. *Rhodobothis paucitesticulare*: 3, Scolex; 4, Immature proglottid; 5, Mature proglottid.

372-651 long by 372-605 wide. Genital pore alternating irregularly in anterior 48-52% ( $\bar{x}$  = 50%,  $n$  = 25) of proglottid; genital atrium well-developed. Cirrus sac 186-279 long by 93-140 wide, containing spined eversible cirrus. Testes 40-80 in number ( $\bar{x}$  = 50,  $n$  = 100) in immature proglottids; few senescent testes present or testes lacking in mature proglottids. Testes subspherical, 24-60 in diameter. Vagina anterior to cirrus sac, sphincter pres-



Figs. 6–11. *Dioecotaenia campbelli*: 6, Scolex; 7, Early mature female proglottid; 8, Mature female proglottid; 9, Gravid female proglottid; 10, Maturing male proglottid; 11, Fully mature male proglottid ready for hypodermic insemination following detachment.

ent. Ovary follicular, bilobed in frontal view, X-shaped in cross section; lobes expanded anteriorly in maturing proglottids, 167–353 long by 373–465 at isthmus. Vitellaria forming lateral bands extending nearly entire length of proglottid; follicles 24–120 in diameter. Uterus saccate, preovarian in mature proglottids. Gravid proglottids not collected.

*Host*.—*Rhinoptera bonasus* (Mitchill).

*Site of infection*.—Spiral valve.

*Locality*.—Gulf of Venezuela, Caimáre Chico, Venezuela.

*Holotype*.—USNM Helm. Coll. No. 75717. Paratypes: USNM Helm. Coll. No. 75718; Univ. Nebraska State Museum No. 21034.

*Etymology*.—The specific name refers to the presence in this species of only about half as many testes per proglottid as are present in members of the other known species.

*Remarks*.—Campbell and Carvajal (1979) reviewed *Rhodobothrium* Linton, 1889, recognizing it as the senior synonym of *Inermiphyllidium* Riser,

1955 and *Sphaerobothrium* Euzet, 1959. They considered *R. pulvinatum* Linton, 1889, *R. lubeti* (Euzet, 1959) Campbell and Carvajal, 1979, and *R. mesodesmum* (Bahamonde and Lopez, 1962) Campbell and Carvajal, 1979 members of *Rhodobothrium* and *R. brachyascum* (Riser, 1955) Campbell and Carvajal, 1979 a provisional member of the genus. The new species differs from the above by exhibiting approximately half as many testes per proglottid, 40–80 with a mean of 50 vs. 117–149, 120–160, and 150–210, respectively for the 3 species listed above. *Rhodobothrium paucitesticulare* further differs by being more markedly protandric. No evidence beyond ovarian anlagen indicates female genitalia in proglottids containing fully developed testes. The testes senesce markedly in proglottids containing developing ovaries and other female genitalia.

Such an observed ontogenetic feature is of potential interest when hosts for *Rhodobothrium* species are compared. *Rhodobothrium lubeti* and *R. mesodesmum* infect *Myliobatis* spp., *R. pulvinatum* infects members of *Dasyatis*, and the new species infects *Rhinoptera bonasus*. *Rhinoptera bonasus* already is known to host the only dioecious tetraphyllidean cestode (we describe another species from the same host next), raising the possibility that the presence of a markedly protandric species of tetraphyllidean in *R. bonasus* relates more to a more general phenomenon involving some aspect of the host's biology.

#### *Dioecotaenia* Schmidt, 1969

Schmidt (1969) redescribed *Rhinebothrium cancellatum* Linton, 1890 and reported it to be a dioecious cestode, the only known such tetraphyllidean. His generic diagnosis was so extensive that a second new species which we describe herein could not be accommodated within the genus unless we emended Schmidt's (1969) diagnosis slightly, as follows:

*Emended diagnosis*.—Tetraphyllidea, Dioecotaeniidae. Sexes completely separate. Sexual dimorphism apparent. Scolex with 4 bothridia on short peduncles, each divided into loculi interpretable as 3 longitudinal rows of equal numbers of loculi or a center row of loculi surrounded by a circle of marginal loculi. Myzorhynchus, accessory suckers, and hooks lacking. Neck present. External segmentation feeble, proglottids acraspedote. Osmoregulatory canals consisting of 6 major medullary trunks, of which the most lateral are highly ramified and anastomose with irregular ducts leading to lateral margins. Cortex thin. Muscle bundles feeble.

Testes medullary, in 2 layers, arranged in a semicircle or circle on all sides of cirrus sac. Genital pores lateral, alternating irregularly. Cirrus sac large, containing spined eversible cirrus and internal seminal vesicle. Cirrus long, armed at base with hooks possessing bifid roots. External seminal vesicle lacking.

Ovary bilobed, transversely elongate, medullary. Oviduct short. Vagina medullary, convoluted; vaginal pore lacking. Seminal receptacle embedded in substance of one ovarian lobe, irregularly alternating sides. Vitellaria compact, surrounding posterolateral margins of both ovarian lobes. Uterus bilobed, saccate, preovarian. Uterine pore preformed, medioventral. Embryo with simple outer membrane. Sperm transfer by hypodermic impregnation. Medullary continuous dorsomedian sheath containing injected cirri present in female. Parasites of elasmobranchs. Type-species: *D. cancellata* (Linton, 1890) Schmidt, 1969. Other species:

*Dioecotaenia campbelli*, sp. nov.

Figs. 6–11

*Description* (based on 15 specimens).—With characters of the genus given above.

Males (7 specimens): Strobila up to 26 mm long by 1.21–1.73 mm wide. Scolex 962–979 long by 1,270–1,490 wide. Bothridia 790–1,023 long by 651–698 wide, possessing 24 loculi arranged either as 3 longitudinal rows of 8 loculi or as a median row of 6 loculi surrounded by 18 marginal loculi. Neck approximately 5 mm long. Strobila with up to 200 proglottids. Testes 60–90 in number ( $\bar{x}$  = 80,  $n$  = 20), 19–36 in diameter. Testes atrophy markedly in posteriormost proglottids as internal seminal vesicle and cirrus sac enlarge. Cirrus sac curved posteriorly, more markedly in older proglottids; sac 279–623 long by 47–139 wide. Genital atrium prominent, capable of protruding as suckerlike papilla, surrounded by darkly-staining parenchymal cells.

Female (8 specimens): Strobila up to 50 mm long by up to 1.9 mm wide. Scolex 962–974 long by 1,270–1,490 wide. Bothridia and neck as in male. Strobila with up to 200 proglottids. Ovary 139–279 long by 465–605 wide. Seminal receptacle 93–139 in diameter. Uterus first a transverse sac, becoming bilobed when gravid, with thin ventral isthmus. Uterine pore near posterior end of proglottid. Eggs 45–65 in diameter, oncospheres 36–48 in diameter.

*Host*.—*Rhinoptera bonasus*.

*Site of infection*.—Spiral valve.

*Locality*.—Gulf of Venezuela, Caimaré Chico, Venezuela.

*Holotype*.—USNM Helm. Coll. No. 75719 (male). Allotype: USNM Helm. Coll. No. 75720 (female). Paratypes: USNM Helm. Coll. No. 75721; Univ. Nebraska State Museum No. 21033.

*Etymology*.—This species is named for Dr. Ronald A. Campbell, South-eastern Massachusetts University, in recognition of his contributions to the systematics of cestodes infecting elasmobranchs.

*Remarks*.—*Dioecotaenia campbelli* closely resembles *D. cancellata*, the only consistent anatomical differences being number of bothridial loculi (24

in the new species vs. 21 in *D. cancellata*) and size of eggs and embryos (36–48  $\mu\text{m}$  in diameter eggs vs. 45–65  $\mu\text{m}$  in diameter eggs; 19–26  $\mu\text{m}$  in diameter oncospheres vs. about 35  $\mu\text{m}$  in diameter oncospheres). Because both species inhabit the same host species and occur in adjacent geographical areas, it seems likely that they are sister-species. Thus, their close morphological similarity does not necessarily indicate any degree of morphological conservatism in *Dioecotaenia*.

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CESTODE PARASITES IN *MYLIOBATIS GOODEI*  
GARMAN (MYLIOBATIFORMES:  
MYLIOBATIDAE) FROM RÍO DE LA PLATA,  
URUGUAY, WITH A SUMMARY OF CESTODES  
COLLECTED FROM SOUTH AMERICAN  
ELASMOBRANCHS DURING 1975-1979

Daniel R. Brooks, Monte A. Mayes, and Thomas B. Thorson

*Abstract.*—Specimens of 7 cestode species, 4 described as new, were collected from spiral valves of 4 *Myliobatis goodei* captured in the La Plata estuary near Montevideo, Uruguay. *Discobothrium arrhynchum* sp. n. differs from all other members of the genus by lacking a myzorhynchus. It most closely resembles *D. myliobatidis* by having relatively large suckers, markedly craspedote immature proglottids, an average of 21 testes per proglottid, and a vagina extending laterally rather than medially to the testes. *Caulobothrium* is recognized as a valid genus but *Rhabdotobothrium* is considered a junior synonym. Two species-groups within *Caulobothrium* are recognized, and a new species in each one is described. *Caulobothrium uruguayense* sp. n. most clearly resembles *C. tetrascaphium* by having more than 100 proglottids per strobila, craspedote proglottids, preovarian testes, more than 100 testes per proglottid, a very long cephalic peduncle, and genital pores in the anterior  $\frac{1}{3}$  of the proglottid. It differs by having 14 or 15 rather than 25 bothridial loculi and recurved rather than straight cirrus sacs. *Caulobothrium ostrowskiae* sp. n. most closely resembles *C. myliobatidis*, *C. opisthorchis* and *C. multorchidum* by exhibiting postovarian testes. The new species differs from *C. opisthorchis* by having fewer testes and by lacking vitelline follicles encircling the postovarian testes; it differs from *C. multorchidum* by having elongate rather than broad flaplike bothridia; and it differs from *C. myliobatidis* by having fewer bothridial loculi. *Rhabdotobothrium dollfusi* and *R. anterophallum* become *Caulobothrium dollfusi* and *C. anterophallum*. *Phyllobothrium myliobatidis* sp. n. differs from *P. auricula*, which it most closely resembles, by having longer and thinner bothridial pedicels and much smaller cirrus sacs. Contracted specimens of *Phyllobothrium* sp. and immature specimens of 2 species of *Acanthobothrium* are briefly described and discussed. A table listing hosts examined and one listing cestodes collected during study of South American elasmobranch parasites from 1975-1979 are included.

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From 1975–1979 the authors collected helminth parasites from a total of 117 euryhaline stingrays captured in various parts of northern and eastern South America. This report represents the last in a series of taxonomic papers reporting our findings. Herein we report helminths parasitizing *Myliobatis goodei* Garman (Myliobatiformes: Myliobatidae) from Río de la Plata, Uruguay and present a list of hosts examined and parasites collected as a result of our study. Specimens representing 7 species of cestodes were collected from the spiral valves of 4 *M. goodei*. All appear to represent new species, but the condition of our material permits description of only 4.

Spiral valves were removed from hosts and placed in ice-water for one hour. They were then slit longitudinally and immersed in 10% formalin for transportation to the laboratory. Spiral valves were systematically dissected and examined for helminth parasites; those present were removed and stored in 70% ethanol. Most collected specimens were stained with Mayer's hematoxylin and mounted in Canada balsam for study as whole mounts. However, some specimens were serially cross-sectioned, cut at 8  $\mu\text{m}$  and stained with hematoxylin-eosin, to confirm certain aspects of proglottid morphology. All figures were drawn with the aid of a drawing tube; measurements are in  $\mu\text{m}$  unless otherwise stated.

*Discobothrium arrhynchum*, sp. nov.

Figs. 1–2

*Description* (based on 30 specimens).—Strobila craspedote, apolytic, aspinose, up to 3,350 long, composed of 43–48 proglottids. Scolex 177–186 long by 233–326 wide, composed of 4 suckers each with lateral flap partially enclosing suckorial opening; suckers and scolex spinose. Suckers 132–216 long by 120–256 wide. Apical organ or myzorhynchus lacking. Cephalic peduncle lacking. Neck extremely short, not measured. Immature proglottids wider than long, markedly craspedote. Mature terminal proglottids 408–672 long by 192–312 wide. Testes 29–72 in diameter, 18–28 ( $\bar{x}$  = 21,  $n$  = 50) in number, 3–4 ( $\bar{x}$  = 3.5) preporally, 5–9 ( $\bar{x}$  = 6.8) postporally, 9–16 ( $\bar{x}$  = 10.7) antiporally. Cirrus sac in anterior  $\frac{1}{3}$  of proglottid, 36–79 long by 12–48 wide, containing unspined eversible cirrus. Genital pore 25–32% ( $\bar{x}$  = 27.5%) of proglottid length from anterior end. Genital atrium shallow, simple. Vagina opening anteriorly to cirrus sac, extending posteriorly lateral to postporal testicular field, reaching near posterior  $\frac{1}{5}$  of proglottid. Ovary in posterior  $\frac{1}{5}$  of proglottid, bialate, 36–96 long by 36–108 wide at isthmus, anterior to posteriormost extent of vagina. Mehlis' gland prominent, ootype immediately posterior to ovarian isthmus. Vitellaria follicular, follicles extending nearly entire length of proglottid, 5–17 in diameter.

*Host*.—*Myliobatis goodei* Garman (Myliobatiformes: Myliobatidae).

Table 1.—South American elasmobranchs examined by the authors for parasitic helminths during 1975–1979.

Host species	Locality	Number	Year(s)
<i>Narcine brasiliensis</i>	Cartagena, Colombia	17	1976
	Isla de Margarita, Venezuela	3	1978
<i>Urolophus jamaicensis</i>	Cartagena, Colombia	5	1976
<i>Urotrygon venezuelae</i>	Cienaga Grande, near Santa Marta, Colombia	1	1975
	Cartagena, Colombia	16	1976
<i>Aetobatis narinari</i>	Cartagena, Colombia	2	1976
	Gulf of Venezuela, Venezuela	1	1978
<i>Rhinoptera bonasus</i>	Gulf of Venezuela, Venezuela	9	1977
<i>Rhinobatus percellens</i>	Cartagena, Colombia	1	1976
	Isla de Margarita, Venezuela	2	1978
<i>Gymnura micrura</i>	Isla de Margarita, Venezuela	2	1978
<i>Dasyatis americana</i>	Cartagena, Colombia	1	1976
	Isla de Margarita, Venezuela	3	1978
<i>Dasyatis guttata</i>	Cienaga Grande, near Santa Marta, Colombia	10	1975–1976
	Cartagena, Colombia	1	1976
	Lake Maracaibo, Venezuela	22	1977–1978
	Isla de Margarita, Venezuela	3	1978
<i>Himantura schmardae</i>	Cienaga Grande, near Santa Marta, Colombia	12	1975–1976
	Lake Maracaibo, Venezuela	2	1977
<i>Myliobatis goodei</i>	La Plata, Uruguay	4	1979

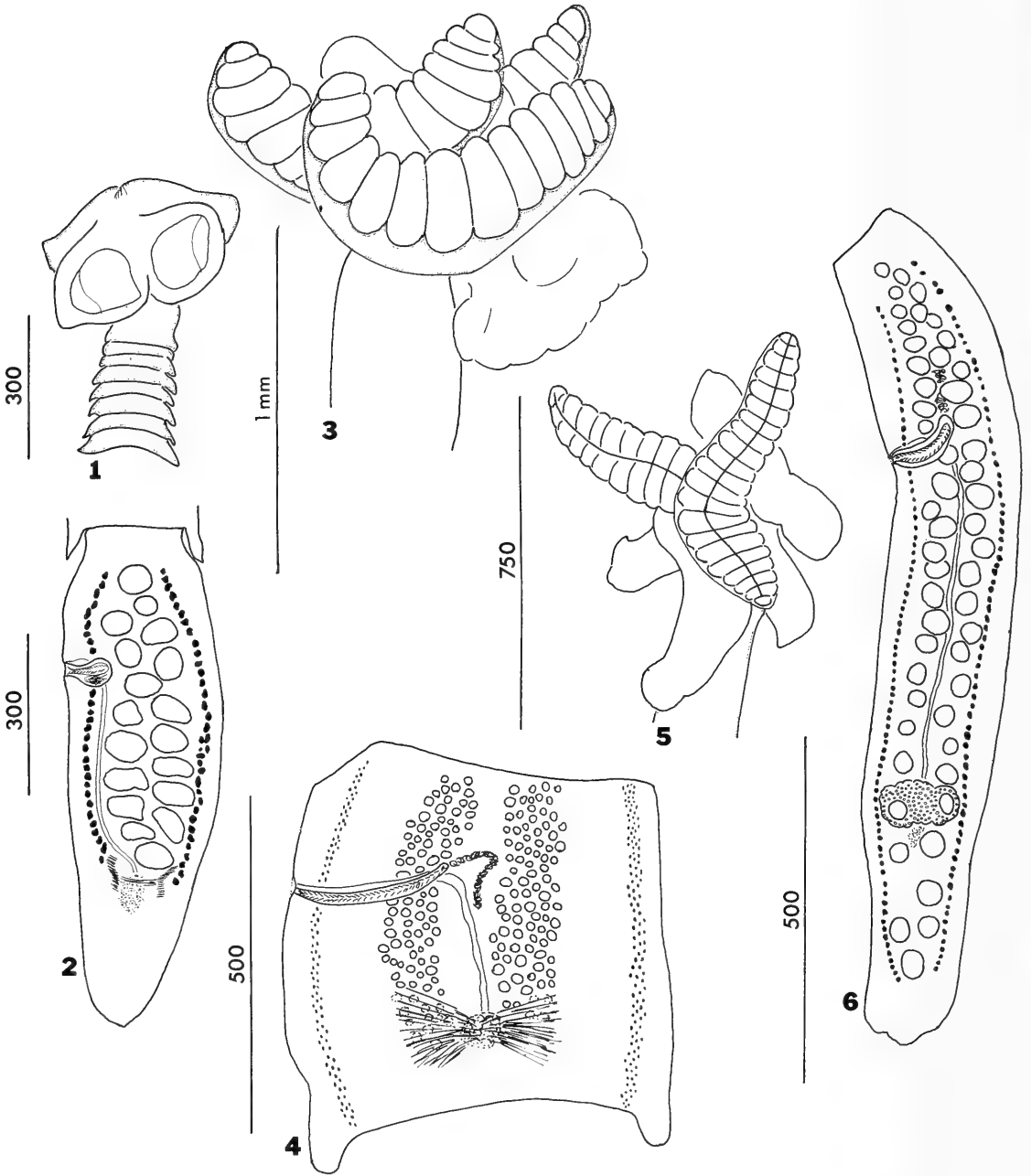
*Site of infection.*—Spiral valve.

*Locality.*—Río de la Plata estuary, near Montevideo, Uruguay.

*Holotype.*—USNM Helm. Coll. No. 75722. Paratypes: USNM Helm. Coll. No. 75723; Univ. Nebraska State Museum No. 21003.

*Discobothrium arrhynchum* differs from all other members of the genus by lacking a myzorhynchus. It most closely resembles *D. myliobatidis* Dailley and Mudry, 1968 and *D. japonicum* Yamaguti, 1934 by having relatively large suckers and *D. myliobatidis* by exhibiting markedly craspedote immature proglottids, an average of 21 testes per proglottid, and a vagina extending posteriorly lateral to the testes rather than medial to them. By possessing 18–28 testes per proglottid, the new species differs markedly from *D. japonicum*, which has 6.





Figs. 1-6. *Discobothrium arrhynchum*: 1, Scolex; 2, Mature proglottid. *Caulobothrium uruguayense*: 3, Scolex; 4, Mature proglottid. *Caulobothrium ostrowskiae*: 5, Scolex; 6, Mature proglottid.

### *Caulobothrium* Baer, 1948

Two recognized genera, *Caulobothrium* Baer, 1948 and *Rhabdotobothrium* Euzet, 1953, possess scolices comprising 4 pedicellated septate bothridia without marginal loculi and no myzorhynchus along with proglottids

exhibiting postvaginal testes. The validity of the genera as natural (monophyletic) groups has been questioned, most recently by Appy and Dailey (1977). Appy and Dailey concluded that the species included in *Caulobothrium* and *Rhabdotobothrium* represented a group distinct from those included in *Rhinebothrium* Linton, 1890 whose species exhibit only prevaginal testes. However, they did not agree that the distinctions between *Caulobothrium* and *Rhabdotobothrium*, the presence or absence of a cephalic peduncle, respectively, constituted valid grounds for generic distinction because species assigned to both *Caulobothrium* and *Rhinebothrium* possess peduncles of varying lengths. We examined type-specimens of the following species of *Caulobothrium* and *Rhabdotobothrium* as well as published descriptions of all 10 previously-known species and specimens of 2 new species described in this paper: *Caulobothrium myliobatidis* Carvajal, 1977 (USNM Helm. Coll. No. 74143), *C. anacolum* Brooks, 1977 (73969, 73970), *C. multorchidum* (Young, 1954) Appy and Dailey, 1977 (45976, 74598), *C. opisthorchis* Riser, 1955 (37415), *C. tetrascaphium* Riser, 1955 (37414), *C. longicolle* (Linton, 1890) Baer, 1948 (7663, 34959, 35940, 36008), and *Rhabdotobothrium anterophallum* Campbell, 1977 (73203-4). We discovered 2 distinct groups regardless of peduncle length. One group of species is characterized by 40 or fewer proglottids per strobila, acraspedote proglottids, and fewer than 100 testes per proglottid. Members of that group include *C. opisthorchis*, *C. multorchidis*, *C. myliobatidis*, *C. anacolum*, and one of the new species described herein. Of those, only *C. anacolum* lacks postovarian testes, a trait unique among rhinebothriine cestodes to the other 4 species. The second group, containing *C. tetrascaphium*, *C. longicolle*, *C. insignis* (Southwell, 1911) Baer, 1948, *C. tobije* (Yamaguti, 1934) Baer, 1948, *Rhabdotobothrium dollfusi* Euzet, 1953, *R. anterophallum*, and the second new species to be described, is characterized by more than 100 proglottids per strobila, craspedote proglottids, preovarian testes, and more than 100 testes per proglottid. Of those species, the 2 placed in *Rhabdotobothrium* lack any cephalic peduncle whereas the other species all possess very long cephalic peduncles. Members of the first group of species all exhibit moderate-length peduncles. Two interpretations seem possible; first, all the above species represent a monophyletic group with 2 divergent lineages or, secondly, each of the 2 groups is derived independently from a different *Rhinebothrium* species-group. In neither case would *Rhabdotobothrium* be logically considered a valid genus unless each of the 2 groups of *Caulobothrium* were also accorded generic status. If the second possibility is true, suggesting that the presence of postvaginal testes is either a homoplastic or plesiomorphic trait, species assigned to *Rhinebothrium* would also have to be segregated into various generic groupings. Pending a phylogenetic analysis of all rhinebothriine groups, we retain *Caulobothrium* and consider *Rhabdotobothrium* a junior subjective synonym. *Rhabdotobothrium dollfusi* be-

comes *Caulobothrium dollfusi* (Euzet, 1953) comb. n. and *R. anterophallum* becomes *C. anterophallum* (Campbell, 1977) comb. n.

*Caulobothrium uruguayense*, sp. nov.

Figs. 3–4.

*Description* (based on 30 specimens).—Strobila craspedote, apolytic, up to 30 mm long, composed of 100–150 proglottids. Scolex with 4 pedicellated bothridia, 825–1,100 long by 825–1,100 wide; pedicels 75–160 long. Bothridia elongate, 930–1,302 long by 232–418 wide, divided horizontally by 13 or 14 septa forming 14 or 15 total loculi. Cephalic peduncle long, aspinose, 1,860–2,418 long. Immature proglottids wider than long. Mature proglottids 465–651 long by 391–512 wide. Testes in anterior  $\frac{4}{5}$  of proglottid, 12–26 in diameter, 136–223 ( $\bar{x}$  = 185,  $n$  = 50) in number, 29–50 ( $\bar{x}$  = 44) preporally, 36–58 ( $\bar{x}$  = 52) postporally, 67–103 ( $\bar{x}$  = 89) antiporally. Cirrus sac in anterior  $\frac{1}{3}$  of proglottid, elongate, posterior end recurved, 72–384 long by 19–36 wide, containing spined eversible cirrus. Genital atrium shallow, simple. Genital pore 32–39% ( $\bar{x}$  = 35%) of proglottid length from anterior end. Vagina anterior to cirrus sac, vaginal sphincter weakly developed. Ovary follicular, bialate, X-shaped in cross section, in posterior  $\frac{1}{5}$  of proglottid, 186–279 long by 326–419 wide at isthmus. Vitellaria follicular, follicles 7–10 in diameter.

*Host*.—*Myliobatis uruguayensis*.

*Site of infection*.—Spiral valve.

*Locality*.—Río de la Plata estuary, Uruguay.

*Holotype*.—USNM Helm. Coll. No. 75724. Paratypes: USNM Helm. Coll. No. 75725; Univ. Nebraska State Museum No. 21002.

*Etymology*.—This species is named after the country in which its host was collected.

*Caulobothrium uruguayense* possesses a very long cephalic peduncle, thus differing from *C. dollfusi* and *C. anterophallum* which lack peduncles. By possessing genital pores in the anterior  $\frac{1}{3}$  of the proglottid, *C. uruguayense* resembles *C. tetrascaphium*; all other species exhibit genital pores at mid-proglottid. The new species differs from *C. tetrascaphium* by possessing 14 or 15 bothridial loculi rather than 25 and by exhibiting cirrus sacs which are curved anteriorly at their posterior ends rather than extending in a direct line or slightly posterior from the genital pore.

*Caulobothrium ostrowskiae*, sp. nov.

Figs. 5–6

*Description* (based on 15 specimens).—Strobila acraspedote, apolytic, composed of 16–20 proglottids, up to 15 mm long. Scolex with 4 pedicellated bothridia, 550–825 long by 550–825 wide; pedicels 93–112 long. Bothridia

elongate, 744–791 long by 279–326 wide, divided longitudinally by single median septum, horizontally by 17–19 septa forming 2 parallel rows of 36, 38, or 40 loculi plus terminal loculus at anterior tip of proglottid; total number of loculi 37, 39, or 41 (mode = 41). Cephalic peduncle aspinose, 232–373 long. Immature proglottids wider than long. Mature proglottids 893–1,256 long by 167–233 wide. Testes extending nearly entire length of proglottid, 19–26 in diameter, 41–63 ( $\bar{x}$  = 52,  $n$  = 25) in number, 6–8 ( $\bar{x}$  = 7) preporally, 13–24 ( $\bar{x}$  = 19) postporally, 21–33 ( $\bar{x}$  = 26) antiporally. Cirrus sac elongate, 72–132 long by 12–17 wide, containing spined eversible cirrus. Genital atrium shallow, simple. Genital pore 25–33% ( $\bar{x}$  = 29%) of proglottid length from anterior end. Vagina anterior to cirrus sac, vaginal sphincter weakly-developed. Ovary in posterior  $\frac{1}{3}$  of proglottid, follicular, bialate, X-shaped in cross section, 36–96 long by 24–60 wide at isthmus. Postovarian testes present. Vitellaria follicular, extending nearly entire length of proglottid; follicles 12–17 in diameter.

*Host*.—*Myliobatis goodei*.

*Site of infection*.—Spiral valve.

*Locality*.—Río de la Plata estuary, near Montevideo, Uruguay.

*Holotype*.—USNM Helm. Coll. No. 75726. Paratypes: USNM Helm. Coll. No. 75727; Univ. Nebraska State Museum No. 21004.

*Etymology*.—This species is named for Dr. Margarita Ostrowski de Núñez, who reported the first known elasmobranch cestodes from the Río de la Plata region.

*Caulobothrium ostrowskiae* resembles *C. myliobatidis*, *C. opisthorchis*, and *C. multorchidum* by exhibiting postovarian testes. *Caulobothrium opisthorchis* differs by having 78–90 rather than 41–63 testes per proglottid and vitelline follicles which encircle the postovarian testes. *Caulobothrium multorchidum* possesses flaplike rather than elongate bothridia which are markedly different from those of the new species. Finally, *C. ostrowskiae* differs from *C. myliobatidis* by having 37–41 rather than 54–58 bothridial loculi.

### *Phyllobothrium* Van Beneden, 1850

The genus *Phyllobothrium* contains a number of species infecting a variety of elasmobranchs and possessing a variety of scolex morphologies (Williams, 1968). The most simplified, and presumably plesiomorphic, morphotype consists of 4 flaplike bothridia lacking a muscular rim and therefore lacking a distinct shape. Some species possessing such bothridia have apical suckers surmounting each bothridium and some do not; likewise, some species possess marginal loculi, such as *P. centrurum* Southwell, 1925 or even marginal loculi and horizontal septa across the face of the bothridia, producing medial loculi, as in *Phyllobothrium kingae* Schmidt, 1978. The

genus almost certainly represents a polyphyletic group whose phylogenetic relationships are virtually unknown. Williams (1968) suggested that members of the genus be catalogued and identified according to their hosts. However, in this study we collected specimens of 2 species of *Phyllobothrium*, a large species with the archetypa scolex morphology and a second, smaller species possessing amorphous bothridia and marginal loculi. Therefore, for convenience and better consistency we prefer to catalogue *Phyllobothrium* species according to general scolex morphology, recognizing that only a thorough phylogenetic analysis will produce an adequate classification of the species involved.

*Phyllobothrium myliobatidis*, sp. nov.

Figs. 7–9

*Description* (based on 4 specimens).—Strobila acraspedote, apolytic, composed of 50–75 proglottids, up to 30 mm long. Scolex up to 2.5 mm wide, composed of 4 pedicellated bothridia with marginal loculi. Pedicels 419–512 long. Bothridia 651–1,395 wide, amorphous, with single row of 83–90 marginal loculi. Cephalic peduncle aspinose, 1,023–1,302 long. Immature proglottids wider than long. Mature proglottids 465–2,418 long by 251–474 wide. Testes in anterior  $\frac{3}{4}$  of proglottid, 24–72 in diameter, in single field of 122–150 in number. Cirrus sac in anterior  $\frac{1}{3}$  of proglottid, elongate, 168–240 long by 84–168 wide, containing spined eversible cirrus. Genital atrium shallow, simple. Genital pore 15–27% of proglottid length from anterior end. Vagina anterior to cirrus sac, vaginal sphincter present. Ovary in posterior  $\frac{1}{5}$  of proglottid, H-shaped with posterior lobes expanding posteriorly as proglottid matures; ovarian lobes X-shaped in cross section, follicular. Vitellaria follicular; follicles 7–24 in diameter, extending entire length of proglottid, becoming more extensive as proglottid matures. Terminal proglottids possessing vitelline fields extending into medial portion of proglottid dorsally and ventrally.

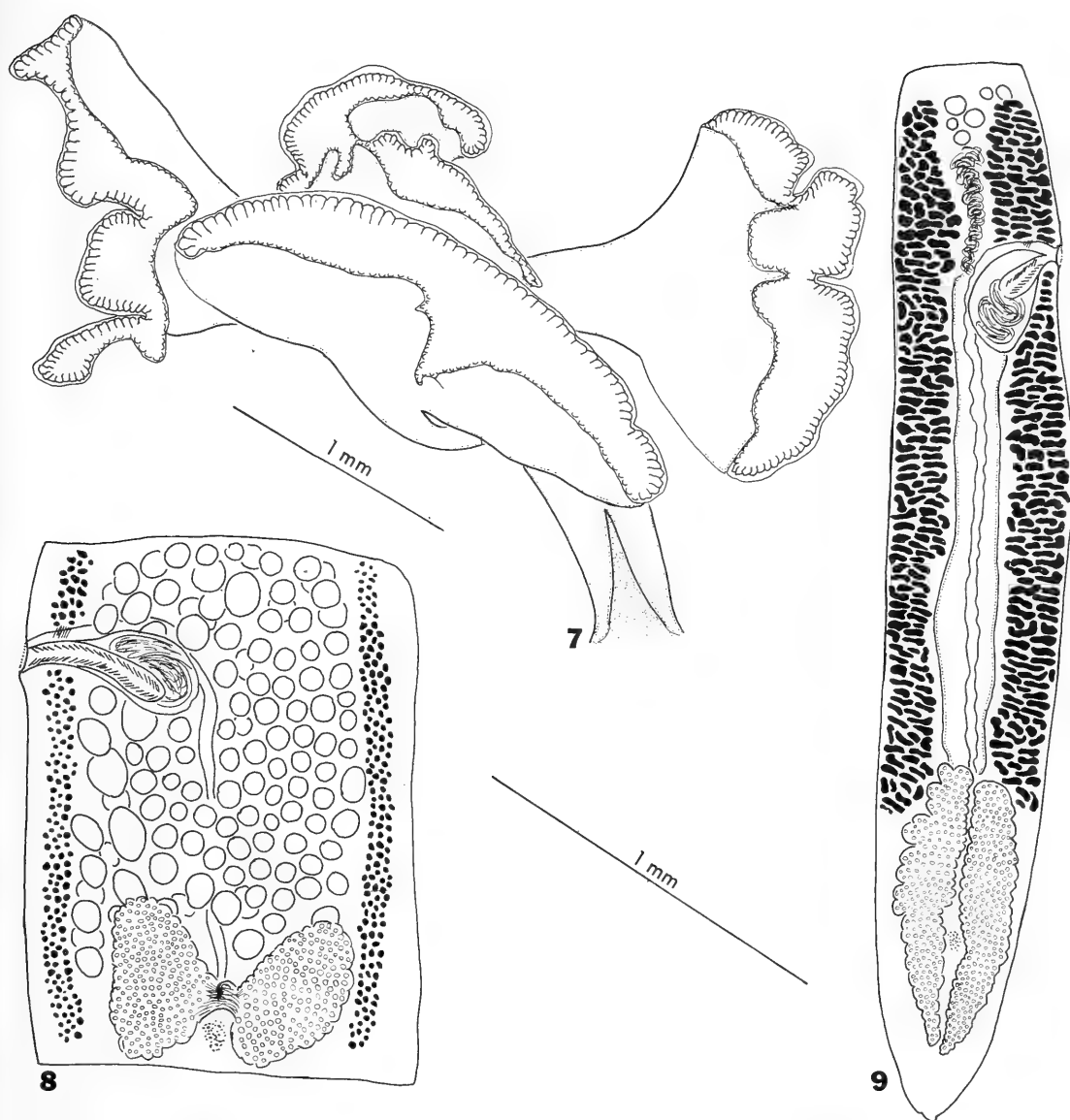
*Host*.—*Myliobatis goodei*.

*Site of infection*.—Spiral valve.

*Locality*.—Río de la Plata estuary, Uruguay.

*Holotype*.—USNM Helm. Coll. No. 75728. Paratypes: USNM Helm. Coll. No. 75729.

*Phyllobothrium myliobatidis* most closely resembles *P. auricula* Beneden, 1858 by having acraspedote proglottids with genital pores in the anterior  $\frac{1}{3}$  and 122–150 testes, band-like vitellaria which proliferate as the proglottid matures, and by having similar ovarian and bothridial morphology (marginal loculi with no transverse septa present on bothridia). Euzet's (1959) illustration of *P. auricula* shows an apical sucker on each bothridium



Figs. 7–9. *Phyllobothrium myliobatidis*: 7, Scolex; 8, Mature proglottid; 9, Gravid proglottid.

which appears more like a strongly developed marginal loculus than a true sucker. The new species exhibits a similar structure in some specimens. *Phyllobothrium myliobatidis* differs from *P. auricula* primarily by exhibiting longer and thinner bothridial pedicels, and by having cirrus sacs 168–240  $\mu\text{m}$  long by 84–168  $\mu\text{m}$  wide whereas those in *P. auricula* measure up to 400  $\mu\text{m}$  long by 200  $\mu\text{m}$  wide. *Phyllobothrium auricula* parasitizes *Dasyatis pastinaca* in French coastal waters while *P. myliobatidis* occurs in *Myliobatis goodei* from Uruguayan coastal waters.

*Phyllobothrium* sp.

*Host*.—*Myliobatis goodei*.

*Site of infection*.—Spiral valve.

*Locality*.—Río de la Plata estuary Uruguay.

*Specimens deposited*.—Univ. Nebraska State Museum No. 21001.

Ten specimens of a species of *Phyllobothrium* possessing amorphous bothridia lacking apical suckers or marginal loculi infected one *M. goodei*. The specimens were too contracted for adequate identification or description, but we have deposited all specimens in hope that they will aid future workers.

*Acanthobothrium* sp.

*Host*.—*Myliobatis goodei*.

*Site of infection*.—Spiral valve.

*Locality*.—Río de la Plata estuary, Uruguay.

*Specimens deposited*.—Univ. Nebraska State Museum No. 21000.

A single intact contracted specimen of a large species of *Acanthobothrium* occurred in one *M. goodei*. The species, apparently undescribed, belongs to a group of species characterized by large size, anapolyosis, long aspinose cephalic peduncles, expanded necks, sessile and relatively broad bothridia, large and robust bothridial hooks, more than 100 proglottids per strobila, flat follicular ovaries, more than 100 testes per proglottid, and relatively square proglottids. Due to the contracted nature of the strobila in our single specimen, we present only the following partial description:

Scolex 825 long by 1,017 wide, comprised of 4 sessile trilobulate bothridia each surmounted by apical pad and sucker, armed with pair of bifid hooks; bothridia connected by velum at posterior ends. Bothridia 651–670 long by 409–418 wide; ratio of length to width 1:0.63. Ratio of locular lengths 1:0.44:0.32. Apical pad 326–335 in diameter; suckers 74–93 in diameter. Bothridia hook prongs markedly dimorphic. Bothridial hook formula (modified from that of Euzet, 1956):

$$\frac{108 \quad 96-120 \quad 55-72}{204-211}$$

Neck expanded at insertion to scolex, aspinose. Cephalic peduncle 1,925 long, aspinose. More than 100 proglottids present. Mature proglottids apparently wider than long to squared. Ovary follicular, with flat lobes.

*Acanthobothrium* sp.

*Host*.—*Myliobatis goodei*.

*Site of infection*.—Spiral valve.

*Locality*.—Río de la Plata estuary, Uruguay.

*Specimen deposited*.—Univ. Nebraska State Museum No. 20999.

We collected a single apparently very young specimen of *Acanthobothrium* possessing 2 elongate immature proglottids. We present a description of the scolex of this specimen:

Scolex 825 long by 1,237 wide, comprised of 4 trilobulate bothridia free at posterior end, each surmounted by apical pad and sucker, armed with pair of bifid hooks. Bothridia 837–930 long by 604–698 wide; ratio of locular lengths 1:0.75:0.90. Apical pad 192 in diameter, sucker 72 in diameter. Bothridial hook formula (modified from that of Euzet, 1956):

41–48	84–89	96–99
<hr/>		
137–144		

Neck expanded at insertion to scolex, spinose.

Ostrowski de Nuñez (1971) reported 2 species of *Acanthobothrium* from the Argentinean side of the La Plata estuary infecting *Zapteryx brevirostris* (Müller and Henle) (Rhinobatiformes: Rhinobatidae). She collected a single immature specimen, *Acanthobothrium* sp., possessing markedly dimorphic bothridial hook prongs, and bothridial hook proportions, scolex, and strobilar morphology similar to the first specimen listed above. However, both hook prongs and thus the total hook length in our specimens are greater (96–120 vs. 78 for the inner prong, 55–72 vs. 26–39 for the outer prong, and 204–211 vs. 156–169 for total hook length) than that reported by Ostrowski de Nuñez (1971). It is possible that both specimens represent the same species. The second species reported by Ostrowski de Nuñez, *Acanthobothrium zapterycum*, exhibits smaller scolex dimensions and bothridial hook sizes as adults than does the single immature specimen we collected. Thus, at least 3 and possibly 4 different species of *Acanthobothrium* occur in stingrays inhabiting the La Plata region, although only one has been named.

Discussion

As mentioned in the introduction, this paper concludes a 5-year study of the cestode parasites infecting marine elasmobranchs along the eastern and northern coast of South America. Table 1 presents the hosts collected and



Table 2.—Cestode species collected in South American marine elasmobranchs during 1975–1979.

## COLOMBIA

*DASYATIS AMERICANA**Phyllobothrium* cf. *kingae* Brooks and Mayes, 1980*Polypocephalus medusius*: Brooks and Mayes, 1980*Lecanicephalum peltatum*: Brooks and Mayes, 1980*HIMANTURA SCHMARDAE**Acanthobothroides thorsoni* Brooks, 1977*Acanthobothrium tasajerasi* Brooks, 1977*Acanthobothrium himanturi* Brooks, 1977*Rhinebothrium magniphallum* Brooks, 1977*Rhinebothrium tetralobatum* Brooks, 1977  
*Caulobothrium anacolum* Brooks, 1977*UROLOPHUS JAMAICENSIS**Acanthobothrium cartagenensis* Brooks and Mayes, 1980*Phyllobothrium* cf. *kingae* Brooks and Mayes, 1980*Rhinebothrium magniphallum*: Brooks and Mayes, 1980*UROTRYGON VENEZUELAE**Acanthobothrium urotrygoni* Brooks and Mayes, 1980*Rhinebothrium magniphallum*: Brooks and Mayes, 1980*AETOBATIS NARINARI**Acanthobothrium colombianum* Brooks and Mayes, 1980*NARCINE BRASILIENSIS**Acanthobothrium lintoni*: Brooks and Mayes, 1978*Acanthobothrium electricolum* Brooks and Mayes, 1978

## VENEZUELA

*NARCINE BRASILIENSIS**Acanthobothrium electricolum*: Mayes and Brooks, 1980*RHINOPTERA BONASUS**Rhinoptercola megacantha*: Mayes and Brooks, 1980*Dioecotaenia campbelli* Mayes and Brooks, 1980*Rhodobothrium paucitesticulare* Mayes and Brooks, 1980*Tylocephalum* sp. Mayes and Brooks, 1980*GYMNURA MICRURA**Acanthobothrium fogeli*: Mayes and Brooks, 1980*AETOBATUS NARINARI**Acanthobothrium tortum*: Mayes and Brooks, 1980*Disculiceps* sp. Mayes and Brooks, 1981

Table 2.—Continued.

<i>HIMANTURA SCHMARDAE</i>	
<i>Parachristianella</i> cf. <i>monomegacantha</i> Mayes and Brooks, 1980	<i>Rhinebothrium magniphallum</i> : Mayes and Brooks, 1980
<i>DASYATIS GUTTATA</i>	
<i>Acanthobothroides thorsoni</i> : Mayes and Brooks, 1980	<i>Rhodobothrium pulvinatum</i> : Mayes and Brooks, 1980
<i>Acanthobothrium tasajerasi</i> : Mayes and Brooks, 1980	<i>Rhinebothrium magniphallum</i> : Mayes and Brooks, 1980
<i>Acanthobothrium urotrygoni</i> : Mayes and Brooks, 1980	<i>Rhinebothrium margaritense</i> Mayes and Brooks, 1980
<i>DASYATIS AMERICANA</i>	
<i>Acanthobothrium americanum</i> : Mayes and Brooks, 1980	<i>Rhinebothrium corymbum</i> : Mayes and Brooks, 1980
<i>Phyllobothrium centrurum</i> : Mayes and Brooks, 1980	<i>Rhinebothrium margaritense</i> Mayes and Brooks, 1980
<i>Rhodobothrium pulvinatum</i> : Mayes and Brooks, 1980	
URUGUAY	
<i>MYLIOBATIS GOODEI</i>	
<i>Discobothrium arrhynchum</i> sp. n.	<i>Phyllobothrium myliobatidis</i> sp. n.
<i>Caulobothrium uruguayense</i> sp. n.	<i>Phyllobothrium</i> sp.
<i>Caulobothrium ostrowskiae</i> sp. n.	<i>Acanthobothrium</i> sp.
<i>Acanthobothrium</i> sp.	

the collection localities, and Table 2 presents an annotated list of the cestodes we collected.

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NOTES ON *AXIOPSIS (AXIOPSIS) SERRATIFRONS*  
(A. MILNE EDWARDS) (CRUSTACEA:  
DECAPODA: THALASSINIDEA)

Brian Kensley

*Abstract.*—*Axiopsis (Axiopsis) serratifrons* (A. Milne Edwards) is recorded for the first time from several localities in the Atlantic. The species is redescribed, and observations on geographical distribution, morphological variation, and behavior in captivity are provided. It is concluded that this is a widely distributed tropical shallow water species.

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The capture of several specimens of the common axiid shrimp inhabiting the shallow back-reef area at Carrie Bow Cay, Belize, led to problems of identification, which were complicated by examination of material from Florida and Bermuda. That axiid taxonomy, especially the status of the genera, is in flux (de Saint Laurent, 1979) did not help to resolve these problems. It was felt that refiguring and describing this, the type-species of the genus *Axiopsis*, and commenting on the range of variation, would cast a little light on axiid taxonomy.

Family Axiidae

*Axiopsis (Axiopsis) serratifrons* (A. Milne Edwards)

Figs. 1-5

*Axia serratifrons* A. Milne Edwards, 1873:11, pl. 2, fig. 6.

*Axiopsis serratifrons*.—Borradaile, 1903:538.—Sandler, 1923:44, pl. 6, fig. 10.

*Axiopsis (Axiopsis) serratifrons*.—de Man, 1925:72, pl. 6, fig. 12.

*Axius serratifrons*.—Rathbun, 1906:895.—Edmondson, 1923:27.

*Axius spinipes* de Man, 1888:464, pl. 19, fig. 6.—Zehntner, 1894:195.

*Axiopsis spinipes*.—Nobili, 1906:91.—Borradaile, 1903:538; 1910:262.

*Axius affinis* de Man, 1888:469, pl. 20, fig. 1.

*Axiopsis affinis*.—Borradaile, 1903:538; 1904:752.—Nobili, 1906:92.

*Description.*—*Male*. Carapace strongly sclerotised, with scattered shallow pits over entire surface posterior to cervical groove; rostrum triangular, extending beyond eyes, margins dentate/spinose, continuous with spinose lateral carina of gastric region of carapace; lateral carina not quite reaching cervical groove posteriorly; spinose median carine starting at about mid-length of rostrum and extending as far as lateral and submedian carinae;

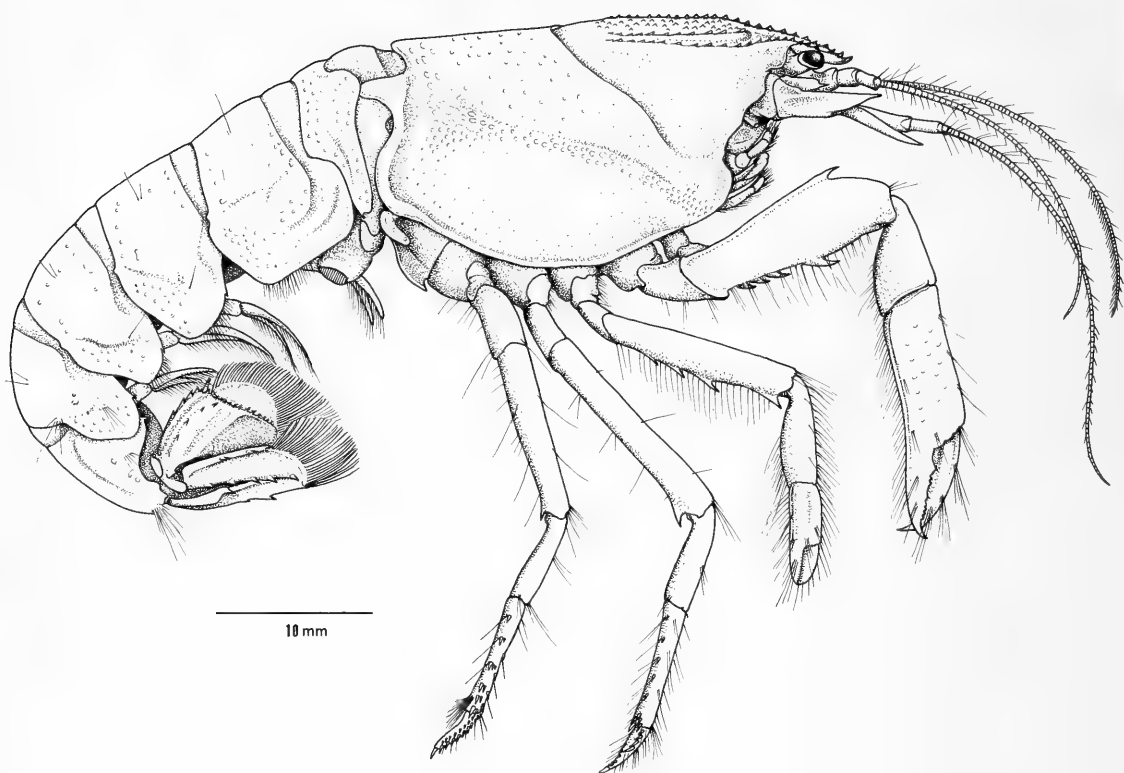


Fig. 1. *Axiopsis (A.) serratifrons*. Adult in lateral view.

latter starting in gastric region, spinose; numerous rounded and acute scattered tubercles between median and submedian carinae; antennal spine very short, subacute; anteroventral region of carapace broadly rounded; supra-branchial groove faint.

Pleon segments with scattered shallow pits. Pleuron of pleonite 1 ventrolaterally narrowed, with short distal marginal spine; pleuron of pleonite 2 broadly rectangular; pleura of pleonites 3–6 each with ventrolateral marginal spine.

Eyes extending to distal end of basal antennular segment; latter with short distolateral spine; second and third segments subequal; flagella equal in length. Antenna with outer peduncle spines flattened, elongate; inner spines short; fifth segment about two-thirds length of fourth. Mandibular palp 3-segmented, second segment twice length of basal segment; third segment longer and broader than second, with cluster of short curved spines on rounded apex; cutting edge bluntly rounded; molar transverse, rounded, with outer part hollowed. Maxilla 1 bilobed, both lobes distally broad, bearing short spines and setae; slender sparsely setose exopod 2-segmented. Maxilla 2, posterior lobe of scaphognathite with elongate modified seta armed with tiny spinules. Maxilliped 1 with broad bilobed epipodite. Maxilliped 2 terminal segment of endopod armed with short curved spines;

fourth segment elongate, with elongate setae on median margin; epipodite narrow, flattened, with attached podobranch. Maxilliped 3 with dactylus and propodus setose; carpus with single distal spine; merus with 4 spines on median margin increasing in length distally; ischium with 3 short spines on median margin, triquetral, inner surface with row of about 20 spines on raised ridge; basal segment with apically acute lobe on inner distal angle; epipodite slender, elongate, with attached podobranch. Pereopod 1, smaller cheliped, with fingers of chela shorter than palm, with ragged cutting edges; palm parallel-sided; carpus shorter than propodal palm; merus with single strong spine on upper margin, lower margin with 4 strong spines; ischium with 4 spines on inner ventral margin; coxa with short mediodistal spine. Larger cheliped, fingers only slightly shorter than palm; dactylus distally strongly curved, with single strong triangular tooth proximally; propodal finger with several tiny teeth proximally, becoming more irregular distally, inner and outer propodal surfaces bearing low tubercles. Pereopod 2 fingers slightly shorter than palm of chela, cutting edges straight, armed with short spines; carpus equal in length to chela; merus and ischium each with 4 spines on ventral margin; coxa with hooked spine at posterodistal corner. Pereopod 3 dactylus with 2 rows of short articulating ventral spines; propodus with single row of about 6 short spines on outer ventral submargin, distal spine strongest; carpus shorter than propodus, unarmed; merus with single strong ventrodistal spine; coxa with hooked spine at posterodistal corner. Dactylus of pereopod 4 with 2 rows of spines on outer surface; propodus with 2 rows of spine clusters on outer surface, plus dense ventrodistal cluster of slender finely serrate spines; carpus shorter than propodus, unarmed; merus with single ventrodistal spine; coxa with median hooked spine; sternal plate with strong anteriorly-directed spine on somewhat flattened process on each side. Pereopod 5 shorter than pereopod 4, dactylus with several ventral spines; grooming apparatus consisting of proximal hollow in dactylus with row of peg-like scales on outer margin; hollow accommodating ventrodistal spinose lobe of propodus, latter with several simple and dentate spines, plus dense cluster of ventrodistal slender finely serrate spines; carpus about half length of propodus; merus, ischium, basis, and coxa unarmed; flattened articulating plate at outer proximal part of coxa distally either with single spine and small papilla or (more often in Belize material), bispinose. First pleopods absent. Endopod of pleopod 2 with slender appendix interna bearing distal patch of short hooks; appendix masculina slightly shorter but broader than appendix interna, with 7 elongate simple distal setae. Outer uropodal ramus with row of 11 to 13 small spines along transverse articulation in distal quarter, strong articulating spine on outer margin at transverse articulation; outer surface with 2 strong rounded ridges, outer ridge bearing 4 spines; outer margin with 4 distal spines; inner uropodal ramus with 3 spines on outer (anterior) margin, single strong ridge

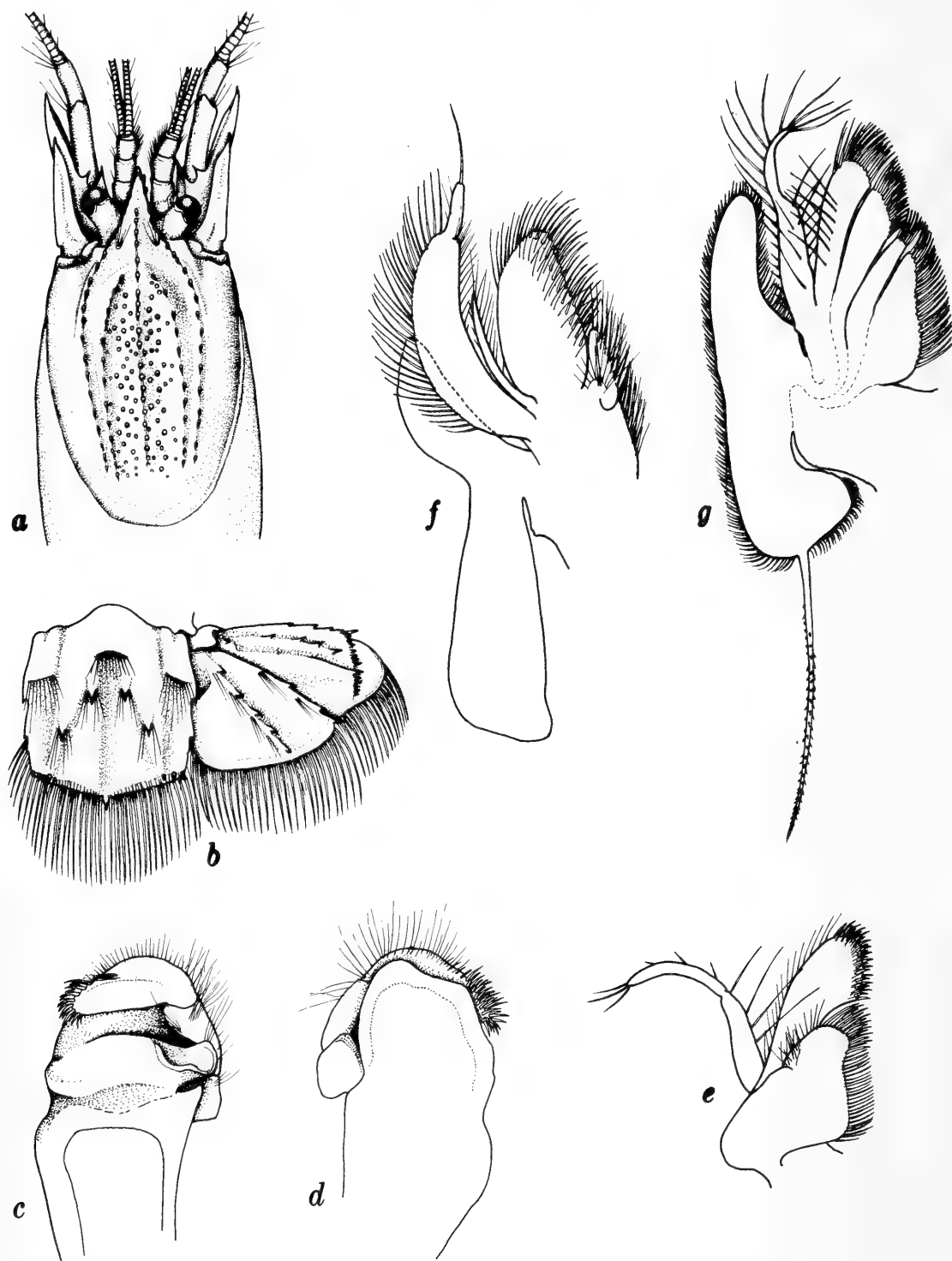


Fig. 2. *Axiopsis (A.) serratifrons*: a, Anterior carapace in dorsal view; b, Telson and right uropod; c, Mandible, inner view; d, Mandible, outer view; e, Maxilla 1; f, Maxilliped 1; g, Maxilla 2.

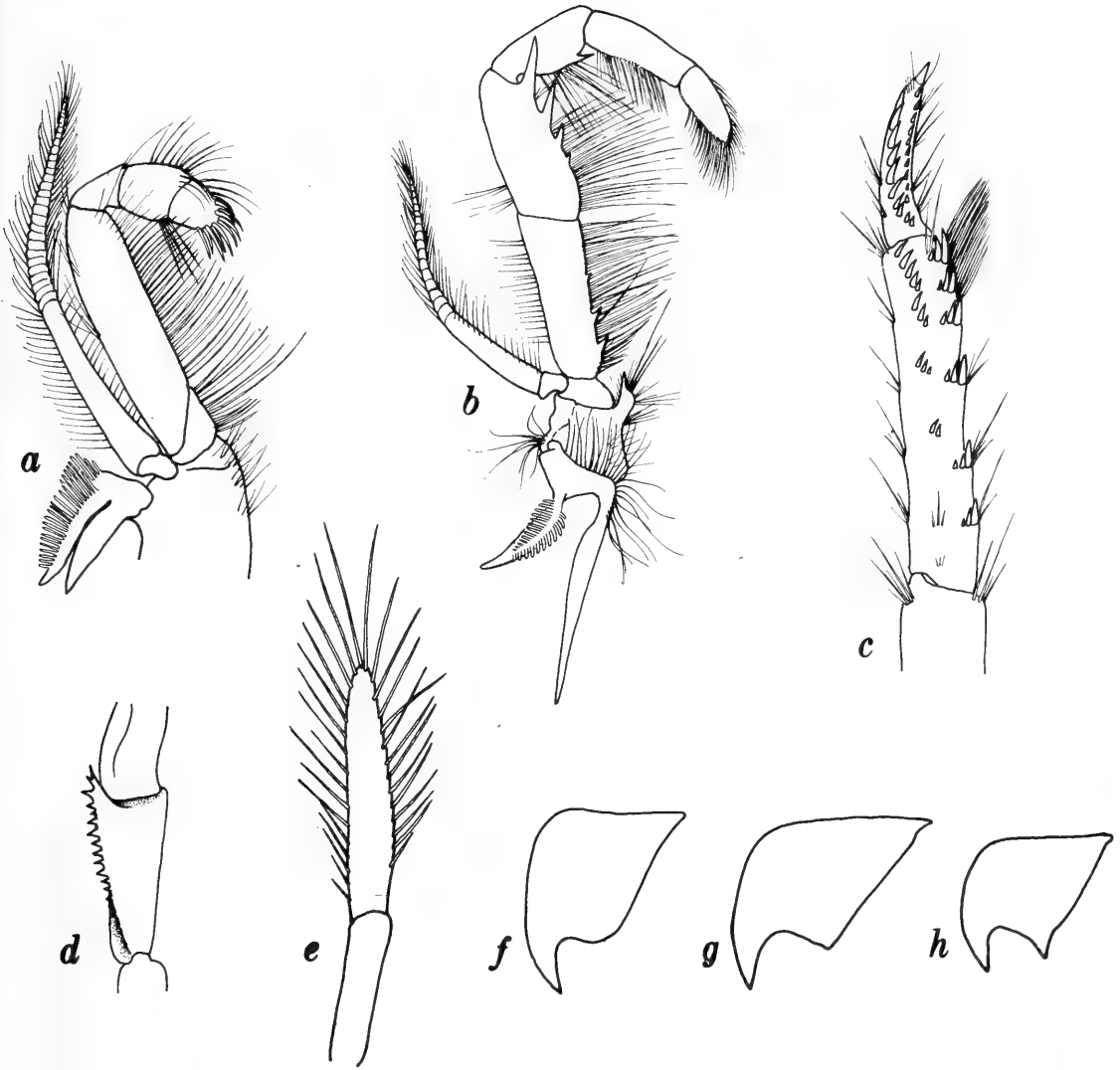


Fig. 3. a, *Axiopsis (A.) serratifrons*: Maxilliped 2; b, Maxilliped 3; c, Pereopod 4, dactylus and propodus; d, Maxilliped 3, inner view of ischium; e, Pleopod 1 ♀; f, Pereopod 5 coxal plate, Gilbert Island specimen; g, Pereopod 5 coxal plate, Bermuda specimen; h, Pereopod 5 coxal plate, Carrie Bow Cay specimen.

on outer surface bearing 5 spines. Telson with short median spine on distal margin; latter almost straight, with 3 small submarginal spines laterally; lateral margin with 2 strong spines; outer surface with 2 broadly rounded ridges each ending in strong spine on each half; distal margins of both uropodal rami and telson bearing dense plumose setae.

*Female*.—Essentially similar to male, first pereopods more robust. Pleopod 1 2-segmented, slender, distal segment bearing marginal plumose setae.



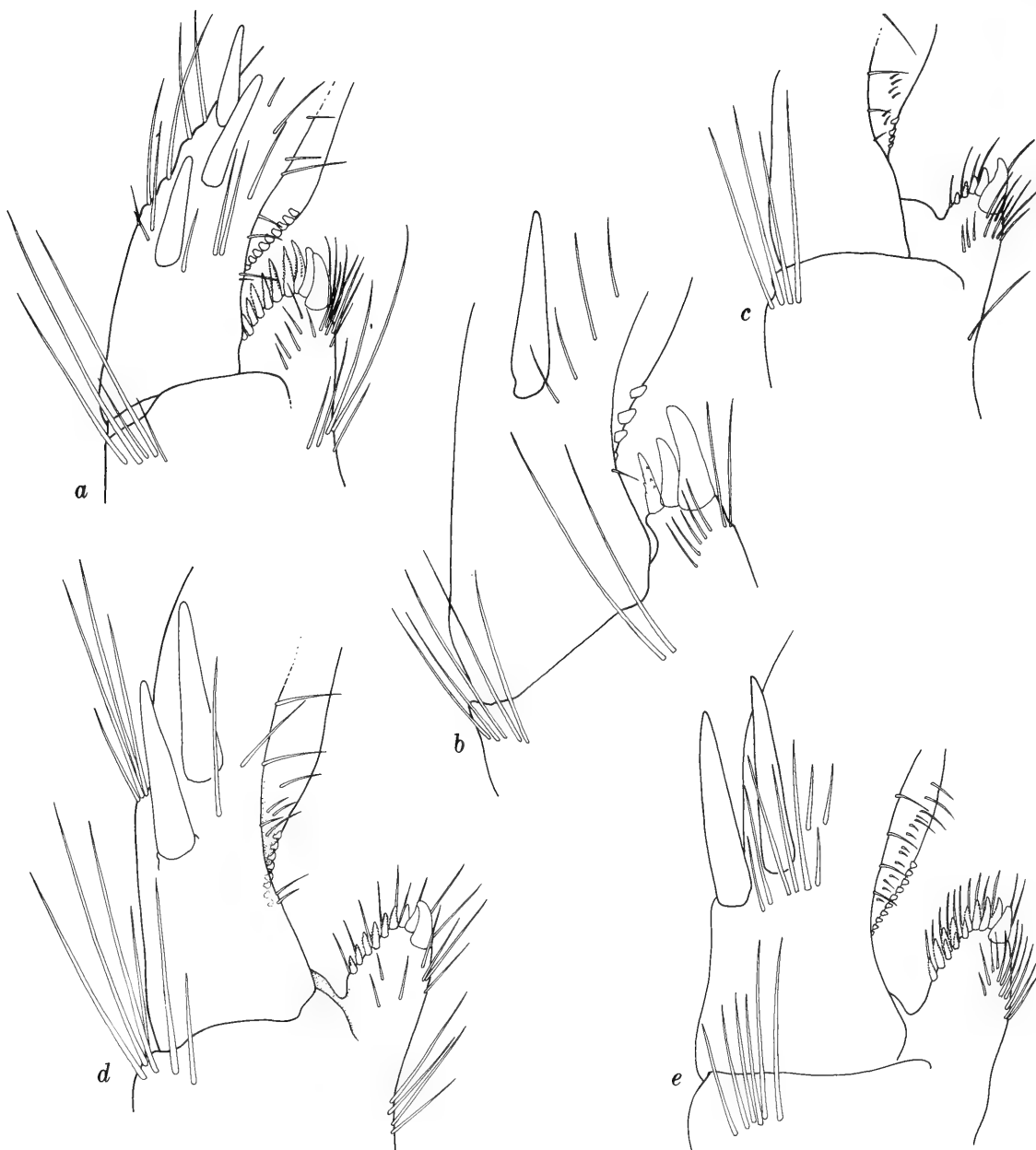


Fig. 4. *Axiopsis* (*A.*) *serratifrons*, grooming apparatus of pereopod 5: a, Gilbert Island; b, Zululand; c, Bermuda; d, Carrie Bow Cay; e, Florida.

*Branchial formula.*—

Maxilliped 2	epipodite + podobranch
Maxilliped 3	2 arthrobranchs, epipodite + podobranch
Pereopod 1	2 arthrobranchs, epipodite + podobranch
Pereopod 2	2 arthrobranchs, epipodite + podobranch
Pereopod 3	2 arthropods, epipodite + podobranch
Pereopod 4	2 arthrobranchs, epipodite

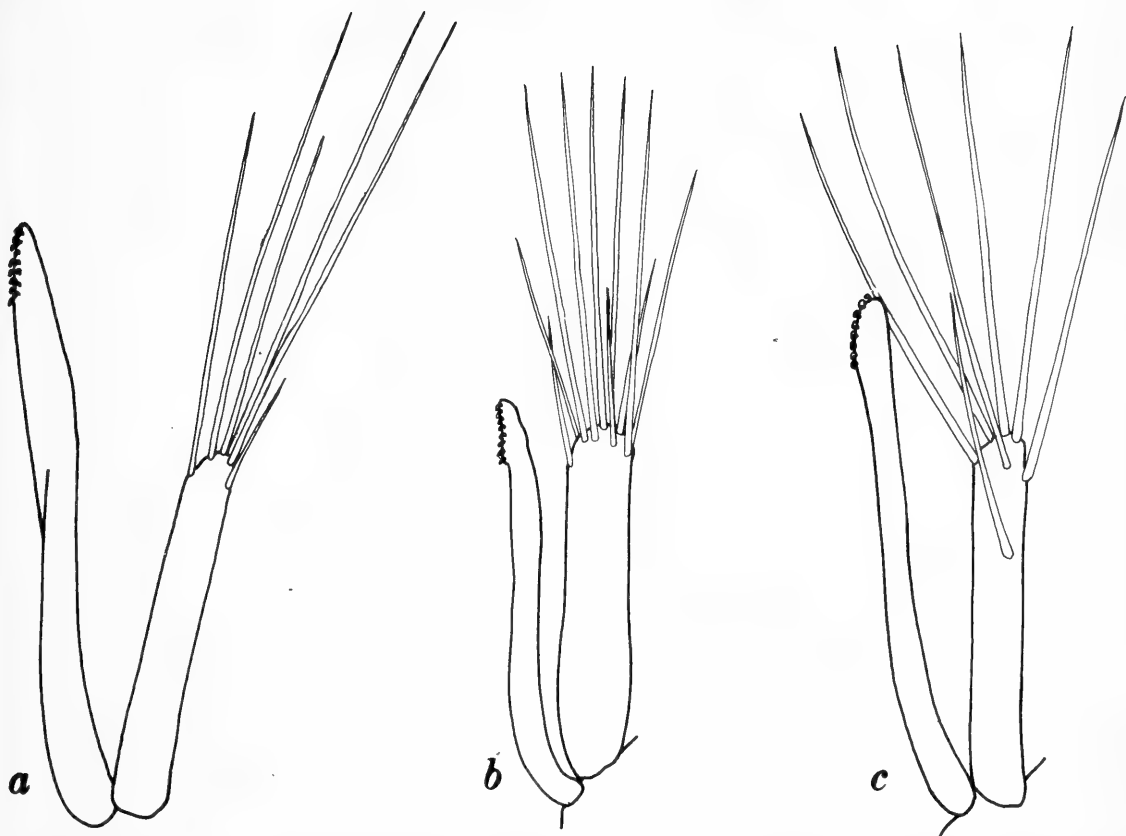


Fig. 5. *Axiopsis* (A.) *serratifrons*, appendix masculina and appendix interna: a, Bermuda; b, Gilbert Island; c, Carrie Bow Cay.

**Color notes.**—(Belize and Bermuda specimens.) Carapace, pleon, and appendages chestnut-brown to almost black in males (becoming purple-blue in alcohol), paler brown to olive green in females. Carapace with pale blotch on posterior branchiostegite and on anteroventral region of cervical groove. Pleura of pleonites 3 to 6 with pale anterior half; middorsal articulating areas of pleonites pale. Finger and thumb of both first chelae orange-brown, rest of cheliped dark.

**Behavioral and biological notes.**—The following observations were made at Carrie Bow Cay, Belize, where *A. (A.) serratifrons* was common in the back-reef area. The shrimps were confined to areas of coarse calcareous sands mixed with dead coral rubble and pieces of pavement rock, in water depths of 0.5–2.0 meters. An estimate of density was difficult, but one burrow per 5 m<sup>2</sup> would not be unreasonable.

The burrows were nearly always situated in shallow depressions, with two or three entrances visible between rubble pieces. The animals could sometimes be seen at the main entrance of the burrow, with the antennae exploring the surrounding area. Even with fish or conch bait, however, the animals could not be induced to leave the burrows.

During March 1980, a mature male and female were captured and placed in a narrow aquarium containing coarse sand and rubble, with circulating sea water. Burrow construction and feeding behavior were observed. When released onto the surface of the sand, rapid movements of the pleon produced a hollow which was soon enlarged by excavation. The first 2 pairs of pereopods plus the third maxillipeds, together with the elongate setae on their ventral margins, form an efficient basket capable of moving considerable quantities of sand, which were dumped beyond the margin of the excavation. Within 24 hours a branching burrow system had been excavated, with interlocking rubble pieces preventing sandfills. The rubble pieces were manipulated with the first pair of chelipeds, and when placed in position, rapidly vibrated as if to ensure or improve solidity. Construction and modification of the burrow continued throughout the 2 weeks of observations. During the day the shrimps never left the burrow, but at night roamed about the surface a little distance from the burrow entrance.

Food in the form of lumps of fish or conch would be dragged into the burrow, and held in place by the third maxillipeds while pieces were torn off by the mandibles. On several occasions, after feeding for a short while, the piece of food was crammed into a crevice and sand piled on top to cover it completely. This food item would be excavated later, more eaten from it, and reburied.

Ventilation of the burrow could sometimes be seen, with either the male or female sitting in the lowest part of the burrow, with the pleon fully extended and the pleopods beating rapidly.

Grooming was frequently performed, the entire body, especially the clumps of setae on the carapace, and the antennular and antennal flagella being combed by the grooming apparatus at the distal end of the fifth pereopods.

*Distribution.*—Pacific Ocean: Hawaii (type-locality); Palmyra Is.; Fanning Is.; Gilbert Is.; Bikini Atoll; Samoa; Palau Is.; Noordwachter Is. (Java Sea); Ambon Is., Obi Is., Damar Is., Lucipara Is., Kur Is., Roti Is. (Indonesia). Indian Ocean: Maldive Is.; Chagos Archipelago; Obock (French Somaliland), Red Sea; Zululand (South Africa). Atlantic Ocean: Belize; Florida; Bermuda.

*Material examined.*—Onotoa, Gilbert Islands, from tidepool; 2 Aug. 1951; det. L. B. Holthuis ovig. ♀, USNM 95559, CL 12.1 mm, TL 29.2 mm; ♀, USNM 95561, CL 14.3 mm, TL 33.2 mm; ♂, USNM 95561, CL 15.0 mm, TL 35.0 mm. Narnu Is., Bikini Atoll, back reef in lagoon, 3 Apr. 1946; det. L. B. Holthuis. ♂, USNM 95560, CL 11.1 mm, TL 27.6 mm. Sodwana Bay, Zululand, South Africa, offshore reef, 50 ft, 24–28 July 1976; ♀, South African Museum, CL 8.8 mm, TL 22.5 mm; 2 juv., South African Museum, CL 6.9 mm, 5.5 mm, TL 17.4 mm, 13.4 mm. Carrie Bow Cay, Belize, back reef coral rubble and coarse sand, 1–2 m, Mar. 1980; ovig.

♀, USNM 18905, CL 23.0 mm, TL 59.0 mm; ♀, USNM 18905, CL 17.8 mm (damaged); 4 ♂, USNM 18905, CL 19.5 mm, 19.0 mm, 15.6 mm, 11.8 mm, TL 50.5 mm (damaged), 39.1 mm, 29.3 mm. Carrie Bow Cay, Belize, coral patches, 1 m, 16 May 1977; 2 juv., USNM 18908, CL 6.0 mm, 5.3 mm, TL 14.0 mm, 12.3 mm. Carrie Bow Cay, Belize, 14 May 1977; juv., USNM 18907, CL 4.2 mm, TL 10.2 mm. Pigeon Key, Monroe County, Florida, under dead coral slab, 2 m, 29 May 1970; ♂, USNM 18903, CL 23.0 mm, TL 62.0 mm. Pigeon Key, Monroe County, Florida, under dead coral, 1.5–2 m, 20 Nov. 1969; ♂, USNM 18904, CL 22.4 mm, TL 58.0 mm. North Rocks, Bermuda, 10 m, 7 Oct. 1976; ♂, juv., CL 15.3 mm, 5.0 mm, TL 40.0 mm, 12.9 mm.

*Discussion.*—The presence of a transverse suture on the outer uropodal ramus, the rounded posterodorsal carapace, the rostrum continuous with the gastric region, elongate antennal spines, and pigmented eyes, place the present species in *Axiopsis* (*Axiopsis*), using de Man's key (1925:1). This definition may be expanded to include a triangular rostrum with dentate margins, unequal first chelipeds with fingers shorter than palm, telson with spinose dorsal keels, pleopod 1 absent in male, and pleopod 2 with rod-shaped appendix interna and appendix masculina. The present species agrees with all these features, and falls into that group of species having five spinose carinae in the gastric region of the carapace. de Man's key to the species of *Axiopsis* leads to *A. serratifrons* (A. Milne Edwards), a species which possesses numerous spines or tubercles between the median and submedian carinae. Although widely distributed throughout the Indo-Pacific, this species has not previously been recorded from the Atlantic.

That *A. serratifrons* from the Indo-Pacific is a variable species, was noted by de Man (1925) when he drew *A. affinis* and *A. spinipes* into the same species. (Borradaile 1903, designated the former as the type-species of the genus.) This variation, also seen in the Atlantic specimens, is to some degree a function of age, the larger and smaller first chelae being more noticeably different in older and fully mature specimens. Variation is also seen in several other morphological features, in addition to the chelipeds. These are summarized in Table 1.

The coxal plate of pereopod 5 varies from having the anterodistal corner rounded, through rectangular, to a spinose condition. In the Belize sample of 6 specimens, this plate is either bispinose or rectangular/spinose, with no apparent correlation with age.

The ventrodistal grooming lobe of the propodus of pereopod 5 is armed with a varying number of dentate and smooth spines, which also vary in relative lengths.

The ratio of length of appendix masculina to appendix interna ranges from 0.6 to 0.9, but may be a function of maturity. The appendix masculina bears a varying number of elongate terminal setae (6–10).

Table 1.—Comparison of material of *A. serratifrons* from 5 localities.

	Belize	Bermuda	Florida	Gilbert Is., Bikini At.	Zululand
<b>Carapace carinae spination</b>					
1 (left)	19–22	20	20–21	18–22	17–19
2	12–14	13	13–14	12–14	10–11
3 (median)	20–24	23	23	14–22	15–17
4	12–14	13	13	12–15	10–12
5 (right)	20–24	20	19–21	17–21	17–19
<b>Marginal spine on pleura</b>	1, 3–6	1, 3–6	1, 3–6	1, 3–6	1, 3–6
<b>Pereopod 1</b>					
Larger chela, length/width	2.1 1.8 1.6	1.6	1.9	1.7 1.6 1.5	1.9
Smaller chela, length/width	2.2 2.5 2.1	2.1	2.7	2.1 1.9	2.3
<b>Pereopod 5, coxal plate</b>	Rectangular to bispinose	Rectan- gular	Rectan- gular	Rounded	Rectan- gular
<b>Pereopod 5, grooming lobe of propodus, spination</b>	9	5	12	10	3
<b>Appendix masculina/appendix interna</b>	0.7	0.6	0.7	0.9	♀
<b>Appendix masculina setation</b>	7 terminal	6 terminal	9 terminal	10 terminal	♀

The palm length/width ratio of the first chelae varies considerably, with the smaller chela being consistently more slender.

Variation in the degree of pitting of the carapace and rugosity of the chelae can also be seen, but is difficult to describe other than in relative terms.

From Table 1 it is difficult to justify splitting the present material either into species or subspecies. The Atlantic population perhaps represents an incursion from the Pacific which took place at a time when the Isthmus of Panama was submerged. A record of the species from the eastern Pacific would strengthen this surmise.

The species recorded by Sakai (1970) as *Axiopsis* (*Axiopsis*) sp. aff. *serratifrons* from Tsushima Is., Japan, is almost certainly not this species, as both the acute anterior margin of the carapace, and the more spinose merus and ischium of maxilliped 3 (as figured by Sakai) differ markedly from Milne Edwards' species.

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**OBANDYELLA, A NEW NAME FOR *HIRSUTELLA*  
BANDY, 1972 (FORAMINIFERIDA),  
NON COOPER AND MUIR-WOOD,  
1951 (BRACHIOPODA)**

D. Haman, R. W. Huddleston, and J. P. Donahue

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Hübner (1822:1-10) erected the genus *Agrodiaetus* to accommodate all 56 species of the European Lycaenidae (Insecta, Lepidoptera) known to him at that time. The author did not, however, designate a type-species for the genus. Hemming (1934:109) subsequently designated *Papilio damon* Denis and Schiffermuller, 1775, as the type-species of *Agrodiaetus* Hübner, 1822 (see also Hemming, 1967:33). Tutt (April 1909a:154) established the genus *Hirsutina* (type-species *Papilio damon* Denis and Schiffermuller, 1775) for representatives of West European butterflies. The same author in the following month (Tutt, May 1909b:108) redundantly redescribed *Hirsutina* with the identical type-species designation. The selection of *Papilio damon* Denis and Schiffermuller, 1775, by Hemming (1934:109) as the type for *Agrodiaetus* Hübner (ICZN Art. 69a, v) consequently made *Hirsutina* Tutt 1909 a junior objective synonym (ICZN Art. 61b).

Kirchner (1933:106) described a new Triassic brachiopod genus from Germany which he named *Hirsutina* (type-species *Spirifer? hirsutus* Alberti, 1864). Despite the fact that *Hirsutina* Tutt, 1909, became a junior objective synonym of *Agrodiaetus* Hübner, 1822 as a result of the action of Hemming (1934) at the time Kirchner (1933) erected *Hirsutina*, the epithet was not available for redesignation (ICZN Art. 17). Consequently, *Hirsutina* Kirchner, 1933 at the time of its establishment became a junior homonym of *Hirsutina* Tutt, 1909. This fact was recognized by Cooper and Muir-Wood (1951:195), and they proposed the replacement name *Hirsutella* for the genus *Hirsutina* Kirchner, 1933 *non* Tutt, 1909.

Bandy (1972:310) in his discussion of the evolutionary lineage of turborotaloids and globorotaloids distinguished three new subgenera of the genus *Globorotalia* Cushman, 1927. These new planktic subgenera were *Fohsella*, type-species *Globorotalia* (F.) *praefohsi* Blow and Banner, 1966; *Menardella*, type-species *G. (M.) menardii* (d'Orbigny, 1826); and *Hirsutella*, type-species *G. (H.) hirsuta* (d'Orbigny, 1839). These subgenera have not been widely recognized by foraminiferologists, a fact commented upon by Stainforth et al. (1975:28, 32). Despite this lack of acceptance by the scientific community, the epithet *Hirsutella* Bandy, 1972, is a junior homonym of *Hirsutella* Cooper and Muir-Wood, 1951, and consequently requires re-

jection and replacement under the Law of Homonymy (ICZN Arts. 52, 53, 56).

The name *Obandyella* is hereby proposed to replace the name *Hirsutella* Bandy, 1972, *non Hirsutella* Cooper and Muir-Wood, 1951. The name is constructed in honor of Orville Lee Bandy (1917–1973) for his pioneer and semantic studies in micropaleontology.

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## A TABULATION OF THE CRUSTACEA DECAPODA OF BERMUDA<sup>1</sup>

John C. Markham and John J. McDermott

*Abstract.*—The first list of decapod crustaceans of the northwestern Atlantic oceanic island group of Bermuda compiled since 1922 is presented. Based on published accounts and recent collections, the list includes 276 species in 48 families; of these, 69 species have not been recorded previously from Bermuda. Only 6 species are endemic. An expanded and fully annotated checklist of Bermudian decapods as well as considerations of the zoogeography of that fauna will be published later.

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Currently in preparation is a field guide to the "Marine fauna and flora of Bermuda" under the joint editorship of Wolfgang and Christiane Sterrer of the Bermuda Biological Station for Research. It is intended that the field guide, containing illustrations, brief descriptions, and ecological notes for all of the common, endemic or otherwise noteworthy species of marine life from Bermuda being prepared by leading specialists, will be published in 1981. A consequence of that project has been much more intensive collecting in Bermuda than had been undertaken in many years. The present tabulation of the Crustacea Decapoda draws in part on material gathered for the field guide, but, unlike the latter, it is intended to be comprehensive in its coverage and is not a manual for identification. It is essentially a very abbreviated version of a report in preparation to be titled "An annotated checklist of the Crustacea Decapoda of Bermuda," which will constitute a Special Publication of the Bermuda Biological Station. That checklist will include all known citations of decapods in and near Bermuda along with a complete catalog of specimens in the collection of the museum of the Bermuda Biological Station and notes on their taxonomy, ecology, breeding periods, etc. Subsequent papers which we anticipate preparing will deal with the zoogeography of certain species or higher taxa of decapods from Bermuda and other aspects of their biology.

The systematic arrangement used for the higher taxa is mainly that of Glaessner (1969). Families and genera of Caridea follow Holthuis (1955), while families and genera in the Brachyura are ordered after Glaessner

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(1969) and Rathbun (1918, 1925, 1930, 1937). Various authorities were consulted for the arrangements of other groups. All specific names, insofar as possible, have been corrected in light of current opinions.

Bermuda, an oceanic island mass lying some 1,000 km off the eastern coast of North America, stands atop the Bermuda Rise, which extends upward from abyssal depths. For purposes of this account, "Bermuda" is that region from land to a depth of 2,750 m (1,500 fathoms) around the islands of Bermuda. This is an irregularly shaped area very close to 4,000 km<sup>2</sup>, approximately within the latitudes from 32°00' to 32°45'N and longitudes from 64°30' to 65°15'W. It extends roughly northeast-southwest and contains Bermuda and its platform, 2 shallow banks to the southwest (*Challenger* and *Plantagenet* [also called *Argus*] Banks) and a deep bank to the northeast.

Although casual observations on Bermuda Decapoda were made from the time of the first settlement of the islands at the start of the 17th century, catalogs of the decapod fauna first appeared only rather recently. The earliest published list of Bermuda decapods was that of Jones (1859), who cited 12 species assignable to eight families, with some remarks on diagnostic characters and habitats in which they occurred. The names which he used were those of close relatives in Europe and boreal North America, but his accounts were good enough so that it is possible to refer them to known Bermuda species. Godet (1960) mentioned 8 species, also by names of species found elsewhere; because of inadequate characterizations, it is difficult to determine all of the species to which he was referring. Heilprin (1888, 1889) made a carefully documented collection and strove to establish the proper names for the 30 decapod species recorded. Hurdis (1897) apparently copied the list of Jones (1859) directly with no attempts to add or to correct names. Two major oceanographic expeditions, the *Challenger* Expedition (reported by Miers, 1886; Bate, 1888; Henderson, 1888; summarized by Cole, 1901) and the Plankton-Expedition (Ortmann, 1893) collected decapods at and near Bermuda, but there was no effort to make the collections comprehensive. Young (1900), without additional collecting, compiled records from most of the authors listed above. He recorded 27 decapod species in 14 families from Bermuda, for which he presented diagnoses, synonymies and numerous illustrations. Rankin (1900), drawing on very well documented collections of his own plus other material available to him and consulting most of the papers then published, recorded 57 decapod species in 17 families from Bermuda, including several new records. Finally, in what remain the standard references, Verrill (1908, 1922) drew up comprehensive accounts of 119 species of Bermuda decapods in 28 families; he presented full descriptions complete with many good illustrations for all of the species including several described as new or recorded for the first time from Bermuda.

## Results

In the list of decapods presented below, the status of many species has been indicated by three symbols. Those whose identification or whose actually documented occurrence in Bermuda is subject to doubt are indicated by question marks (?); there are 10 such species. The 69 species recorded from Bermuda for the first time are labeled with the symbol §. Those species, 6 in number, which are evidently endemic to Bermuda, are denoted with an asterisk (\*). New species are also indicated by "n. sp."; all are anomurans and represent perhaps 5 species.

Table 1, on page 1275 following the list, summarizes the decapod crustaceans by infraorder after the removal of 11 questionable records.

## CRUSTACEA DECAPODA OF BERMUDA

## CLASS CRUSTACEA

## SUBCLASS MALACOSTRACA

## ORDER DECAPODA

## SUBORDER DENDROBRANCHIATA

## INFRAORDER PENAEIDEA

## SUPERFAMILY PENAEOIDEA

## FAMILY PENAEIDAE

<i>Metapenaeopsis goodei</i> (Smith)	<i>Penaeus brasiliensis</i> Latreille
§ <i>M. hobbsi</i> Pérez Farfante	<i>P. duorarum duorarum</i> Burkenroad
<i>M. smithi</i> (Schmitt)	<i>Trachypenaeus constrictus</i> (Stimpson)
<i>Trachypenaeopsis mobilispinus</i> (Rathbun)	

## FAMILY SOLENOCERIDAE

*Hymenopenaeus laevis* (Bate)

## FAMILY SICYONIDAE

*Sicyonia wheeleri* Gurney

## FAMILY ARISTEIDAE

*Gennadas elegans* (Smith)

## SUPERFAMILY SERGESTOIDEA

## FAMILY SERGESTIDAE

## SUBFAMILY LUCIFERINAE

<i>Lucifer faxoni</i> Borradaile	<i>L. typus</i> (H. Milne Edwards)
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## SUBFAMILY SERGESTINAE

<i>Sergestes arachinpodus</i> (Cocco)	<i>S. japonicus</i> Bate
<i>S. armatus</i> (Krøyer)	<i>S. kroyeri</i> Bate
<i>S. atlanticus</i> H. Milne Edwards	<i>S. pectinatus</i> Sund
<i>S. cornutus</i> (Krøyer)	<i>S. robustus</i> Smith
<i>S. crassus</i> Hansen	<i>S. sargassi</i> Ortmann
<i>S. edwardsi</i> Krøyer	<i>S. splendens</i> Hansen
<i>S. grandis</i> Sund	<i>S. talismani</i> Barnard
<i>S. hanseni</i> (Ortmann)	<i>S. tenuiremis</i> Krøyer
	<i>S. vigilax</i> Stimpson

SUBORDER PLEOCYEMATA  
INFRAORDER STENOPODIDEA  
FAMILY STENOPODIDAE

- Stenopus hispidus* (Olivier) *S. scutellatus* Rankin  
§*Microprosthema semilaeve* (Von Martens)?

INFRAORDER CARIDEA  
SUPERFAMILY OPLOPHOROIDEA  
FAMILY OPLOPHORIDAE

- |   |                                      |
|---|--------------------------------------|
| <i>Oplophorus spinicauda</i> A. Milne Edwards | <i>M. marptocheles</i> (Chace)       |
| <i>O. spinosus</i> (Brullé)                   | <i>M. miccycla</i> (Chace)           |
| <i>Acanthephyra acutifrons</i> Bate           | <i>M. mollis</i> (Smith)             |
| <i>A. brevirostris</i> Smith                  | <i>M. vesca</i> (Smith)              |
| <i>A. curtirostris</i> Wood-Mason             | <i>Notostomus distirus</i> Chace     |
| <i>A. eximia</i> Smith                        | <i>N. perlatus</i> Bate              |
| * <i>A. gracilipes</i> Chace                  | <i>N. robustus</i> Smith             |
| <i>A. pelagica</i> (Risso)                    | ? <i>N. westergreni</i> Faxon        |
| <i>A. purpurea</i> A. Milne Edwards           | <i>Ephyrina bifida</i> Stephensen    |
| ? <i>A. rostrata</i> Bate                     | <i>E. hoskynii</i> Wood-Mason        |
| <i>A. stylostrata</i> (Bate)                  | <i>Hymenodora gracilis</i> Smith     |
| * <i>Meningodora compsa</i> (Chace)           | <i>Systellaspis braueri</i> (Balss)  |
|   | <i>S. debilis</i> (A. Milne Edwards) |

SUPERFAMILY PASIPHAEOIDEA  
FAMILY PASIPHAEIDAE

- |  |                                      |
|--|--------------------------------------|
| <i>Pasiphaea hoplocerca</i> Chace      | <i>P. sulcatifrons</i> Smith         |
| <i>P. loicerca</i> Chace               | ? <i>P. gilesii</i> Wood-Mason       |
| <i>Parapasiphae macrodactyla</i> Chace | ? <i>P. serrata</i> Rathbun          |
|  | <i>Leptochela bermudensis</i> Gurney |

SUPERFAMILY BRESILIOIDEA  
FAMILY BRESILIIDAE

- |                              |                                  |
|------------------------------|----------------------------------|
| <i>Lucaya bigelowi</i> Chace | <i>Discias atlanticus</i> Gurney |
|                              | <i>D. serratirostris</i> Lebour  |

FAMILY RHYNCHOCINETIDAE  
*Rhynchocinetes rigens* Gordon

SUPERFAMILY PALAEMONOIDEA  
FAMILY PALAEMONIDAE  
SUBFAMILY PALAEMONINAE

- |                                  |  |
|----------------------------------|--|
| <i>Leander tenuicornis</i> (Say) | <i>Palaemon northropi</i> (Rankin)         |
|                                  | <i>Brachycarpus biunguiculatus</i> (Lucas) |

SUBFAMILY PONTONIINAE

- |  |   |
|--|---|
| <i>Periclimenes americanus</i> (Kingsley)        | § <i>P. perlatus</i> Boone                  |
| <i>P. anthophilus</i> Holthuis & Eibl-Eibesfeldt | § <i>Pontonia mexicana</i> Guérin-Méneville |
| <i>P. harringtoni</i> Lebour                     | <i>Anchistioides antiguensis</i> (Schmitt)  |
| <i>P. irridescent</i> Lebour                     | <i>Typton tortugae</i> McLendon             |
| <i>Periclimenaeus bermudensis</i> (Armstrong)    | § <i>Tuleariocaris neglecta</i> Chace       |

## FAMILY GNATHOPHYLLIDAE

*Gnathophyllum americanum* Guérin-  
Méneville

§*Gnathophylloides mineri* Schmitt

## SUPERFAMILY ALPHEOIDEA

## FAMILY ALPHEIDAE

*Alpheopsis labis* Chace

*A. trigonus* (Rathbun)

§*Neoalpheopsis hummelincki* (Schmitt)

§*Automate gardineri* Coutière

*Salmoneus ortmanni* (Rankin)

§*Alpheus armatus* Rathbun

*A. armillatus* H. Milne Edwards

*A. bahamensis* Rankin

*A. beanii* Verrill

*A. bouvieri* A. Milne Edwards

*A. cylindricus* Kingsley

§*A. floridanus* Kingsley

*A. formosus* (Gibbes)

?*A. heterochaelis* Say

*A. normanni* Kingsley

§*A. nuttingi* (Schmitt)

*A. paracrinitus* Miers

*A. peasei* (Armstrong)

§*A. viridari* (Armstrong)

*A. websteri* Kingsley

?*Synalpheus brevicarpus* Herrick

*S. fritzmuelleri* Coutière

*S. goodei* Coutière

*S. hemphilli* Coutière

?*S. longicarpus* (Herrick)

*S. minus* (Say)

*S. townsendi* Coutière

*Synalpheus* spp.

## FAMILY HIPPOLYTIDAE

*Trachycaris restrictus* (A. Milne Edwards)

*Hippolyte coerulescens* (Fabricius)

*H. zostericola* (Smith)

§*Thor amboinensis* (de Man)

?*T. floridanus* Kingsley

§*T. manningi* Chace

*Latreutes fucorum* (Fabricius)

*Tozeuma carolinense* Kingsley

§*Lysmata grabhami* (Gordon)

*L. intermedia* (Kingsley)

§*L. moorei* (Rathbun)

## FAMILY PROCESSIDAE

*Processa bermudensis* (Rankin)

\**P. wheeleri* Lebour

## SUPERFAMILY PANDALOIDEA

## FAMILY PANDALIDAE

*Parapandalus richardi* (Coutière)

§*Plesionika edwardsii* (Brandt)

*P. martia* (A. Milne Edwards)

*Plesionika* sp.

## FAMILY PHYSETOCARIDIDAE

*Physetocaris microphthalma* Chace

## INFRAORDER ASTACIDEA

## FAMILY NEPHROPIDAE

## SUBFAMILY NEPHROPINAE

*Nephropsis rosea* Bate

## INFRAORDER PALINURA

## SUPERFAMILY PALINUROIDEA

## FAMILY PALINURIDAE

*Justitia longimanus* (H. Milne Edwards)

*Panulirus argus* (Latreille)

*P. guttatus* (Latreille)

*P. laevicauda* (Latreille)

## FAMILY SYNAXIDAE

*Palinurellus gundlachi* Von Martens

## FAMILY SCYLLARIDAE

§*Arctides guineensis* (Spengler)*Scyllarides aequinoctialis* (Lund)*S. nodifer* (Stimpson)

## INFRAORDER ANOMURA

## SUPERFAMILY THALASSINOIDEA

## FAMILY AXIIDAE

§\**Axiopsis* n. sp.

## FAMILY CALLIANASSIDAE

*Callianassa branneri* (Rathbun)*C. longiventris* A. Milne Edwards

## SUPERFAMILY PAGUROIDEA

## FAMILY PAGURIDAE

*Pagurus brevidactylus* (Stimpson)§*Iridopagurus* n. sp.§*P. impressus* (Benedict)

§New genus, new species

§*Iridopagurus violaceus* De Saint Laurent-  
Dechancé

§New genus (?), new species

§Unidentified pagurid genus, species

## FAMILY PARAPAGURIDAE

*Parapagurus pilosimanus* Smith

## SUPERFAMILY COENOBITOIDEA

## FAMILY COENOBITIDAE

*Coenobita clypeatus* (Herbst)

## FAMILY DIOGENIDAE

*Allodardanus bredini* Haig & Provenzano*C. antillensis* Stimpson*Calcinus tibicen* (Herbst)*C. tricolor* (Gibbes)\**C. verrillii* (Rathbun)§*Dardanus imperator* (Miers)§*Cancellus* sp.§*D. insignis* (de Saussure)§*Clibanarius anomalus* A. Milne Edwards &  
Bouvier*D. venosus* (H. Milne Edwards)§*Dardanus* sp.§*Petrochirus diogenes* (Linnaeus)

## SUPERFAMILY GALATHEOIDEA

## FAMILY GALATHEIDAE

## SUBFAMILY GALATHEINAE

\**Munida beanii* Verrill§*M. simplex* Benedict

## SUBFAMILY MUNIDOPSINAE

*Munidopsis serratifrons* (A. Milne Edwards)

## FAMILY PORCELLANIDAE

*Petrolisthes armatus* (Gibbes)

## SUPERFAMILY HIPPOIDEA

## FAMILY ALBUNEIDAE

*Albunea paretii* Guérin

## FAMILY HIPPIDAE

*Hippa testudinaria* (Herbst)

## INFRAORDER BRACHYURA

## SECTION DROMIACEA

## SUPERFAMILY DROMIOIDEA

## FAMILY DROMIIDAE

*Dromia erythropus* (Edwards)*Dromidia antillensis* Stimpson

## SUPERFAMILY HOMOLOIDEA

## FAMILY HOMOLIDAE

§*Homola barbata* (Fabricius)

## SUPERFAMILY ?

## FAMILY HAPALOCARCINIDAE

*Troglocarcinus corallicola* Verrill

## SUPERFAMILY CALAPPOIDEA

## FAMILY CALAPPIDAE

## SUBFAMILY CALAPPINAE

§*Calappa angusta* A. Milne Edwards*C. gallus* (Herbst)*C. flammea* (Herbst)*C. ocellata* Holthuis*Cycloes bairdii* Stimpson

## SUBFAMILY MATUTINAE

§*Osachila antillensis* Rathbun

## FAMILY LEUCOSIIDAE

## SUBFAMILY LEUCOSIINAE

§*Iliacantha subglobosa* Stimpson*Callidactylus asper* Stimpson

## SUPERFAMILY RANINOIDEA

## FAMILY RANINIDAE

§*Symethis variolosa* (Fabricius)

## SECTION OXYRHYNCHA

## FAMILY MAJIDAE

## SUBFAMILY INACHINAE

*Stenorhynchus seticornis* (Herbst)*Podochela riisei* Stimpson

## SUBFAMILY TYCHINAE

§*Pitho* sp.

## SUBFAMILY ACANTHONYCHINAE

*Acanthonyx petiverii* H. Milne Edwards*Epialtus bituberculatus* H. Milne Edwards§*E. longirostris* Stimpson

## SUBFAMILY PISINAE

§*Nibilia antilocapra* (Stimpson)*Chorinus heros* (Herbst)? *Libinia emarginata* Leach

## SUBFAMILY MAJINAE

- Mithrax (Mithrax) acuticornis* Stimpson  
*M. (Mithrax) cornutus* de Saussure  
*M. (Mithrax) hispidus* (Herbst)  
 §*M. (Mithrax) pleuracanthus* Stimpson  
 §*M. (Mithrax) spinosissimus* (Lamarck)  
*M. (Mithraculus) forceps* (A. Milne Edwards)  
*Stenocionops furcata coelata* (A. Milne Edwards)  
 §*S. spinosissima* (de Saussure)  
*Macrocoeloma subparallelum* (Stimpson)  
*M. trispinosum nodipes* (Desbonne)  
 §*Macrocoeloma* sp.  
*Microphrys bicornutus* (Latreille)

## FAMILY PARTHENOPIDAE

## SUBFAMILY PARTHENOPINAE

- §*Parthenope fraterculus* (Stimpson)  
*P. granulata* (Kingsley)  
 §*P. pourtalesii* (Stimpson)  
*P. serrata* (H. Milne Edwards)

## SECTION CANCRIDEA

## FAMILY CANCRIDAE

## SUBFAMILY CANCRINAE

*Cancer borealis* Stimpson

## SECTION BRACHYRHYNCHA

## SUPERFAMILY PORTUNOIDEA

## FAMILY PORTUNIDAE

## SUBFAMILY PORTUNINAE

- Portunus (Portunus) anceps* (de Saussure)  
*P. (Portunus) sayi* (Gibbes)  
*P. (Achelous) depressifrons* (Stimpson)  
*P. (Achelous) ordwayi* (Stimpson)  
*P. (Achelous) sebae* (H. Milne Edwards)  
 §*P. (Achelous) spinicarpus* (Stimpson)  
*P. (Achelous) spinimanus* Latreille  
*Callinectes danae* Smith  
*C. exasperatus* (Gerstaecker)  
*C. marginatus* (A. Milne Edwards)  
*C. ornatus* Ordway  
*C. sapidus* Rathbun  
*Arenaeus cribrarius* (Lamarck)  
 §*Cronius ruber* (Lamarck)  
*C. tumidulus* (Stimpson)

## SUPERFAMILY XANTHOIDEA

## FAMILY XANTHIDAE

- Carpilius corallinus* (Herbst)  
*Paraliomera dispar* (Stimpson)  
*Platypodiella spectabilis* (Herbst)  
 §*Actaea acantha* (H. Milne Edwards)  
 §*A. palmeri* Rathbun  
 §*Actaea* ? sp.  
 §*Allactaea lithostrota* Williams  
 §*Paractaea nodosa* (Stimpson)  
*Platyactaea setigera* (H. Milne Edwards)  
 §*Platyxanthus* sp.  
 §*Cycloxanthops vittatus* (Stimpson)  
*Cataleptodius floridanus* (Gibbes)  
 §*Pseudomedeus agassizi* (A. Milne Edwards)  
 §*Leptodius* sp.  
*Xanthodius americanus* (de Saussure)  
*Xantho denticulatus* (White)  
*Panopeus bermudensis* Benedict & Rathbun  
*P. herbstii* H. Milne Edwards  
*P. occidentalis* de Saussure  
*Eurypanopeus depressus* (Smith)  
 ?*Eurytium limosum* (Say)  
 §*Micropanope sculptipes* Stimpson  
*M. spinipes* A. Milne Edwards  
 §*M. urinator* (A. Milne Edwards)  
 §*Pilumnus dasypodus* Kingsley  
 §*P. floridanus* Stimpson  
 §*P. longleyi* Rathbun  
 §*P. miersi* A. Milne Edwards  
 §*P. sayi* Rathbun  
*Lobopilumnus agassizii* (Stimpson)  
*Heteractaea ceratopus* (Stimpson)  
*Eriphia gonagra* (Fabricius)  
*Domacia acanthophora acanthophora* (Desbonne & Schramm)



## FAMILY GERYONIDAE

*Geryon quinquedens* Smith

## FAMILY GONEPLACIDAE

## SUBFAMILY CARCINOPLACINAE

§*Pilumnoplax*? sp.

## SUBFAMILY EURYPLACINAE

*Euryplax nitida* Stimpson

## FAMILY GRAPSIDAE

## SUBFAMILY GRAPSINAE

*Grapsus grapsus* (Linnaeus)*Pachygrapsus gracilis* (de Saussure)*Geograpsus lividus* (H. Milne Edwards)*P. transversus* (Gibbes)*Goniopsis cruentata* (Latreille)*Planes minutus* (Linnaeus)

## SUBFAMILY VARUNINAE

§*Euchirograpsus americanus* A. Milne Edwards

## SUBFAMILY SESARMINAE

*Sesarma (Holometopus) miersii* Rathbun§*Aratus pisonii* (H. Milne Edwards)*S. (Holometopus) ricordi* H. Milne Edwards*Cyclograpsus integer* (H. Milne Edwards)

## SUBFAMILY PLAGUSIINAE

*Plagusia depressa* (Fabricius)*Percnon gibbesi* (H. Milne Edwards)

## FAMILY GECARCINIDAE

*Cardisoma guanhumi* Latreille*Gecarcinus (Gecarcinus) lateralis lateralis*  
(Freminville)

## SUPERFAMILY OCYPODOIDEA

## FAMILY OCYPODIDAE

## SUBFAMILY OCYPODINAE

*Ocypode quadrata* (Fabricius)

## SUPERFAMILY ?

## FAMILY PALICIDAE

§*Palicus affinis* (A. Milne Edwards &  
Bouvier)§*P. alternatus* Rathbun

## Discussion

The accompanying list includes 276 species (when the "*Synalpheus* spp." are handled as one species) belonging to 48 families. Of these, 69 species (25.0%), including 5 known to be undescribed species, are reported from Bermuda for the first time. Only 6 species (2.2%) are endemic to Bermuda, though if some of the unknown species prove to be new, they may raise that number slightly. With the removal of the 10 dubious species records, the total number becomes 266 species, which are distributed among 7 infraorders as indicated in Table 1.

Table 1.—Crustacea Decapoda of Bermuda—summaries by infraorder after removal of 11 questionable records.

Infraorder	Number of species	% of total	Number of endemics	New records
Penaeidea	29	10.9	0	1
Stenopodidea	3	1.1	0	1
Caridea	89	33.5	3	15
Astacidea	1	0.4	0	0
Palinura	8	3.0	0	1
Anomura	30	11.3	3	14
Brachyura	106	39.8	0	37
TOTALS	266	100.0	6	69

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**CORALAXIUS ABELEI, NEW GENUS AND NEW SPECIES  
(CRUSTACEA: DECAPODA: THALASSINIDEA:  
AXIIDAE): A CORAL-INHABITING SHRIMP  
FROM THE FLORIDA KEYS AND THE  
WESTERN CARIBBEAN SEA**

Brian Kensley and Robert H. Gore

*Abstract.*—*Coralaxius abelei*, gen. et sp. nov., is described from specimens collected from 11 to 76 m on coral reefs or coralline rock habitat, off Carrie Bow Cay, Belize, and Key Largo in the Florida Keys. The new genus closely resembles *Axiopsis* (*Paraxiopsis*) but is separated chiefly by the reduced gill formula, a broad bilobed appendix masculina in the male, biunguiculate dactyls on the last 3 pereopods, and eyestalks longer than the rostrum. The species also exhibits striking cheliped armature, differing from all other Axiidae in the western Atlantic.

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In May and early June 1979 the Office of Coastal Zone Management undertook a geophysical and biological survey for NOAA of the deep water coral reefs within the Key Largo Florida Marine Sanctuary. The Sanctuary extends from the State of Florida Territorial Sea, off Key Largo in the upper Florida Keys, seaward to the 100 m isobath, and encloses an area 20 miles long by 5 miles wide (approximately  $33 \times 8$  km). The 53 specimens of decapod crustaceans collected during reconnaissance dives using a manned submersible in this survey were placed at the first author's disposal. The collection contained several important range extensions and at least 4 new species. One of the specimens, a female, was a thalassinidean shrimp with affinities to the genus *Axiopsis* (*Paraxiopsis*), which differed from the 19 other axiids recorded from the western North Atlantic (de Man 1925; Boesch & Smalley 1972; Williams 1974) in the genera *Axius*, *Axiopsis*, and *Calocaris* s.l.

The description of the new species had already been accepted for publication when the second author, in conversation with the first, discovered that the latter had found and prepared a description of the same species using material collected by the Smithsonian Institution's Investigations of Marine Shallow-Water Ecosystems team at Carrie Bow Cay, Belize. The first author had placed his material in a new genus based primarily on branchial formula and the form of the male pleopod 2. Accordingly, we combined our respective descriptions into this report, thereby preventing certain synonymy.

Abbreviations are as follows: **Rcl** (rostral spine-carapace length), **cw** (widest part of carapace), **ch** (highest part of carapace), **Tl** (rostral spine tip to telson posterior margin). Paratypes have been deposited in the Rijksmuseum van Natuurlijke Historie, Leiden (RNHL) and British Museum (Natural History) (BMNH).

*Coralaxius*, new genus

*Diagnosis*.—Uropodal exopod with distinct, spined suture; posterior dorsal carapace region rounded, smooth, without median carina; rostrum sharply produced, triangular, margins unarmed, shorter than eyestalks, situated at lower level from and discontinuous with gastric region; antennal acicle small, flattened, distally trispinose; eyes pigmented; pereopods 3–5 biunguiculate; chelipeds unequal, fingers of larger chela longer or shorter than palm; maxilliped 2 with simple epipodite; maxilliped 3 with simple podobranch and epipodite; 2 arthrobranchs on maxilliped 3, and pereopods 1–4, gills hardly branched; pleopod 1 of male bilobed, with reduced stylamblys, pleopod 2 with rod-shaped appendix interna and broad, bilobed appendix masculina.

*Remarks*.—The new genus is close to *Calocaris* Bell, 1853, *Calastacus* Faxon, 1893, and the genus *Axiopsis* s.l. Borradaile, 1903. For *Coralaxius*, the greatest weight is given to the very different gill arrangement (Table 1), to the unusual form of the appendix masculina of pleopod 2 in the male, and to the presence of biunguiculate dactyls on the last 3 pairs of pereopods. These and other differences are summarized in Table 2 using data from original descriptions or examination of type-specimens in the taxa under consideration. For several of the characters information was not available in the description, and the figures provided could be misconstrued, hence the data are somewhat provisional.

*Etymology*.—The generic name is derived from “Coral” where the shrimp were found, the “axius” from the type-genus in the Axiidae. Gender: masculine.

*Coralaxius abelei*, new species

Figs. 1–6

*Material*.—Holotype: female, Rcl 4.5, cw 2.6, ch 2.7, Tl 12.8 mm; Atlantic Ocean, French Reef, off Key Largo, Monroe Co., Florida; 25°02'N, 80°19'W; 76 m; by manipulator from Research Submersible Johnson-Sea-Link I; 3 June 1979; G. Shinn collector. USNM 173629.

Allotype: Male, Rcl 2.7, cw 1.3, ch 1.4, Tl 7.6 mm; Caribbean Sea, Carrie Bow Cay, Belize; 11 m; by hand, from live specimen of *Porites* coral; 2 February 1978; R. Larson collector. USNM 170857.

Paratypes: (All localities Carrie Bow Cay, Belize.) 1 female, Rcl 3.5, cw

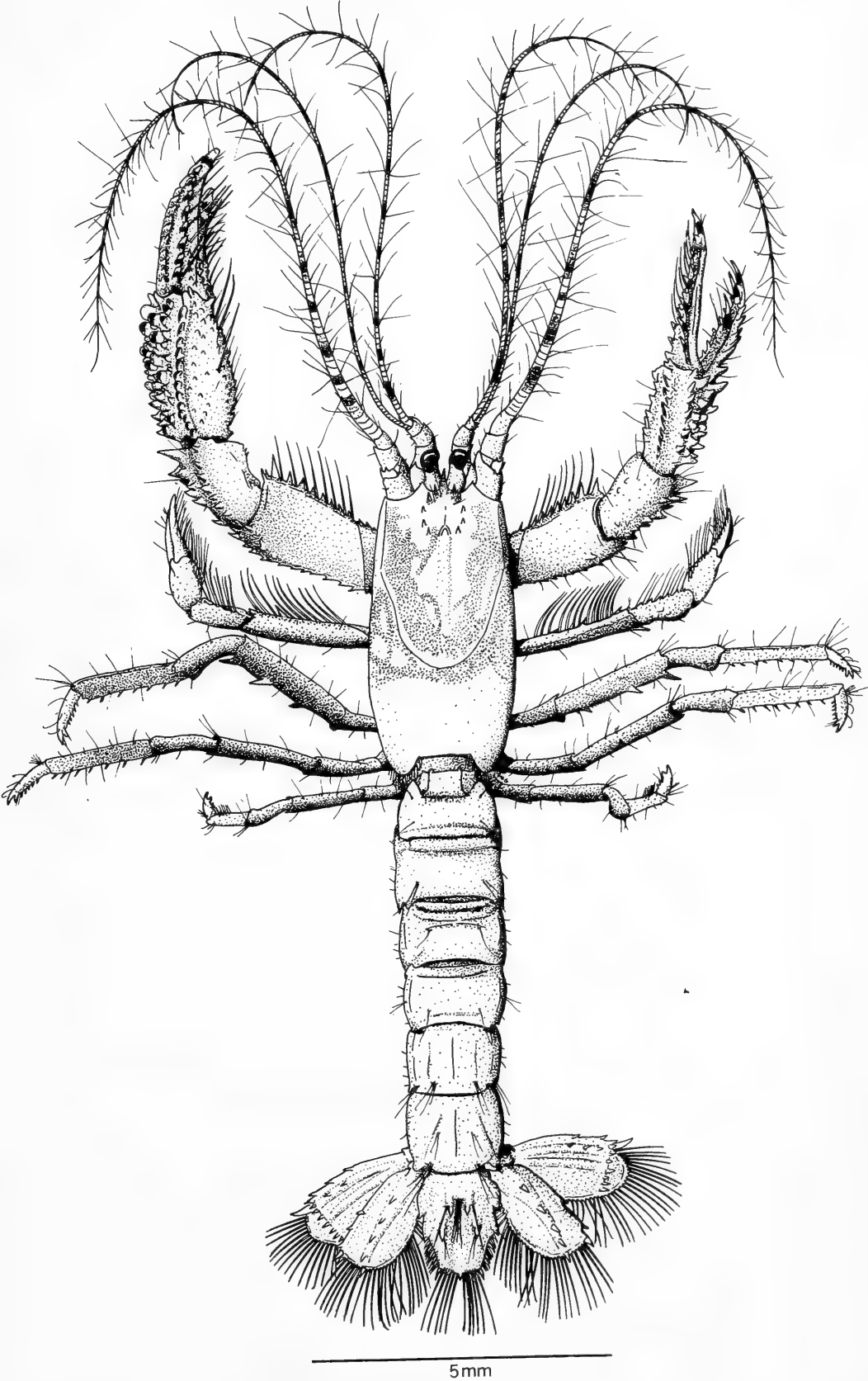


Fig. 1. *Coralaxius abelei*: Holotype female in dorsal view.

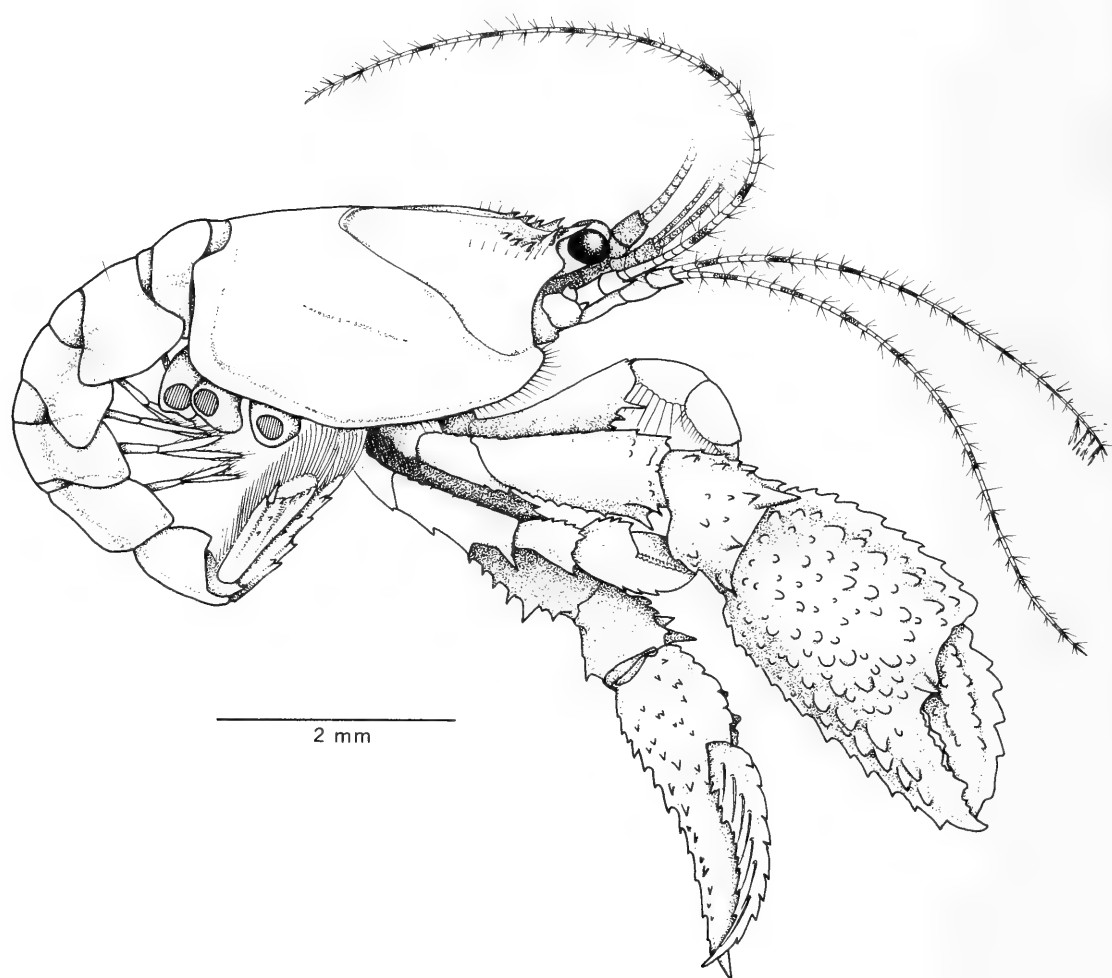


Fig. 2. *Coralaxius abelei*: Adult in lateral view, pereopods 3–5 removed.

1.7, ch 1.7, Tl 9.6 mm; 15 m; 7 February 1978; R. Larson & B. Kensley collectors. USNM 170856.—1 male (dissected & illustrated), Rcl 2.8, cw 1.3, ch not available, Tl 9.5 mm; 2 females, Rcl 3.3, 2.6, cw 1.5, 1.1, ch 1.6, 1.4, Tl 9.6, 7.5 mm, respectively; 15 m; 7 February 1978; R. Larson & B. Kensley collectors. USNM 170858.—1 male, Rcl 2.9, cw 2.1, ch 1.5, Tl 9.0; 2 females, Rcl 4.5, 4.3, cw 1.8, 2.4, ch 2.5, 2.2, Tl 13.4, 10.5 mm, respectively; 26 m; 23 March 1978; R. Larson & B. Kensley collectors. USNM 171765.—1 male, Rcl 2.7, cw 1.4, ch 1.5, Tl 7.7 mm; 26–30 m; 26 March 1978; R. Larson & B. Kensley collectors. USNM 171766.—1 male, Rcl 2.3, cw 0.9, ch 1.3, Tl 6.4 mm; 1 female, Rcl 3.8, cw 1.5, ch 2.0, Tl 9.9 mm; 26 m; 27 March 1978; R. Highsmith & B. Kensley collectors. USNM 171764.—1 male, Rcl 3.5, cw 1.5, ch 2.0, Tl 9.0 mm; 13 m; 28 March 1978; R. Highsmith & B. Kensley collectors. USNM 171763.—2 males, Rcl 4.5 (gonopod illustrated), 4.4, cw 1.4, 2.2, ch 2.0, 2.2, Tl ca. 10.5 (telson broken), 12.2



Fig. 3. *Coralaxius abelei*: Live adult from Carrie Bow Cay, Belize (Photograph by R. Larson).



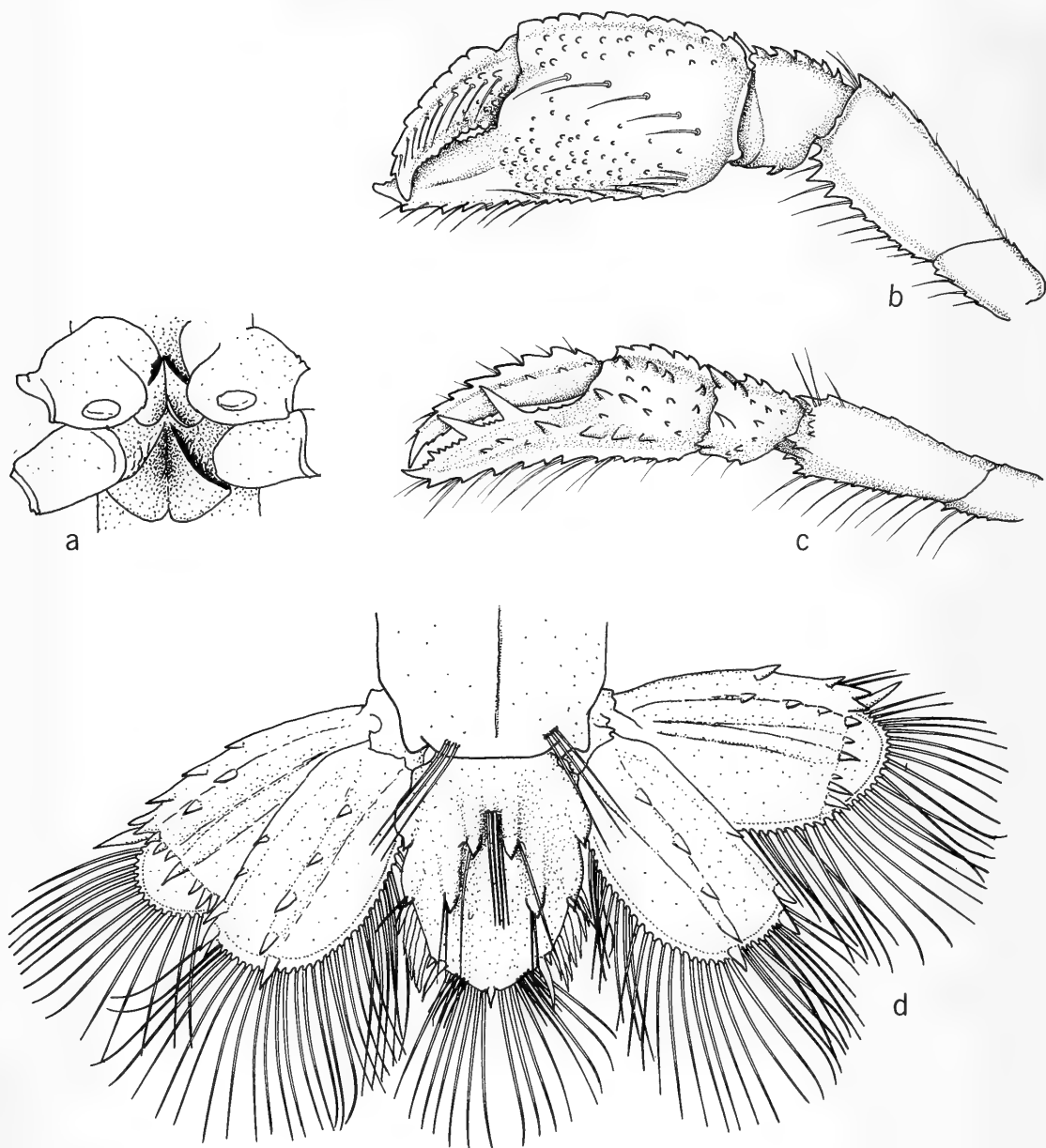


Fig. 4. *Coralaxius abelei*: a, Sternal anterior and posterior processes; b, Larger cheliped, inner view; c, Smaller cheliped, outer view; d, Telson and uropoda.

mm, respectively; 3 females (1 ovigerous), Rcl (5.0), 4.3, 2.5, cw (2.2), 2.2, 1.3, ch (2.2), 2.1, 1.7, Tl (12.5), 11.0, 6.3 mm, respectively; 21 m; 22 March 1979; B. Kensley collector. RMHNL.—2 males, Rcl 4.1, 3.8, cw 2.1, 1.9, ch 1.7, 2.1, Tl 11.8, 11.3 mm, respectively; 28 m; 12 March 1980. B. Kensley collector. BMNH.

*Diagnosis*.—Characters as for genus with the following additions, suspected to be diagnostic at the species level: gastric region with low, thin,

median carina joining raised, posteriorly bifurcate tooth from which extends posteriorly a rounded ridge; 2 semicircular rows of 5 spines each join with rostral spine and pyramidal tooth to form distinct gastric corona; minor chela with 3 elongate fanglike teeth on cutting edge of fixed finger; major and minor chelipeds heavily armed with short sharp spines and tubercles.

*Description.*—Carapace smooth, shining; cervical groove distinct, no posterior median carina dorsally; rostrum sharply produced, acutely triangular, margins entire, curving anterodorsally, reaching about half length of eye-stalk; carapace in lateral view with dorsum depressed posterior to rostrum, but rising to meet gastric tooth; gastric region sloping anteroventrally, a low median carina joining raised tooth, latter bifurcating gently posteriad, merging along dorsal midline of carapace into low, rounded, carinate ridge becoming obsolete towards cephalic groove; shallow depression either side of this ridge; on either side of rostral spine, a semicircular row of 5 spines, extending posteriorly and forming with the rostral spine and gastric tooth, a sparsely setose gastric corona; outer orbital angle produced into blunt tooth; anterior carapace margin smooth, oblique ventrally, unarmed; posterior margin rounded dorsally, becoming sinuously concave below, with row of small, plumose setae extending dorsally along this margin to just inside large median notch of posterodorsal margin.

Abdominal somites smooth, shining, with scattered setae dorsally and laterally, either singly or in small tufts; somites 1–5 of about equal length middorsally, somite 6 slightly longer; fifth and sixth, medially carinate, carina of sixth stronger than fifth. Ventrolateral margins of all somites except first and sixth truncately rounded, fringed with hairs; pleuron of first produced posteroventrally into bluntly rounded tooth, that of sixth with posterolateral margin angled, emarginate to accommodate uropodal base.

Eyestalk subglobose proximally, becoming more or less cylindrical distally; cornea well developed, pigmented, wider than stalk, just reaching distal end of basal antennular segment.

Antennular peduncle 3-segmented, extending well beyond tips of eyes; basal article equal to, or slightly overreaching eyestalk, with small spine distoventrally, 3 short spines on medial margin, single spine on convex outer margin; stylocerite about half eyestalk length, with single spinule on distal margin; second article subequal to, third article about  $\frac{1}{3}$  of, eyestalk length, both unarmed. Flagella longer than carapace length, heavily setose throughout, inner flagellum thicker than outer.

Antennal peduncle compressed, 3-segmented, basal article with single ventral spine medial to antennal gland opening; second article about half length of first, dorsally bearing small, flattened, bi- or trispinose scalelike acicle, second small articulating scale ventrolaterally; third subequal to first, unarmed; terminal article  $\frac{2}{3}$  length of first; flagella heavily setose throughout length, about twice carapace length.

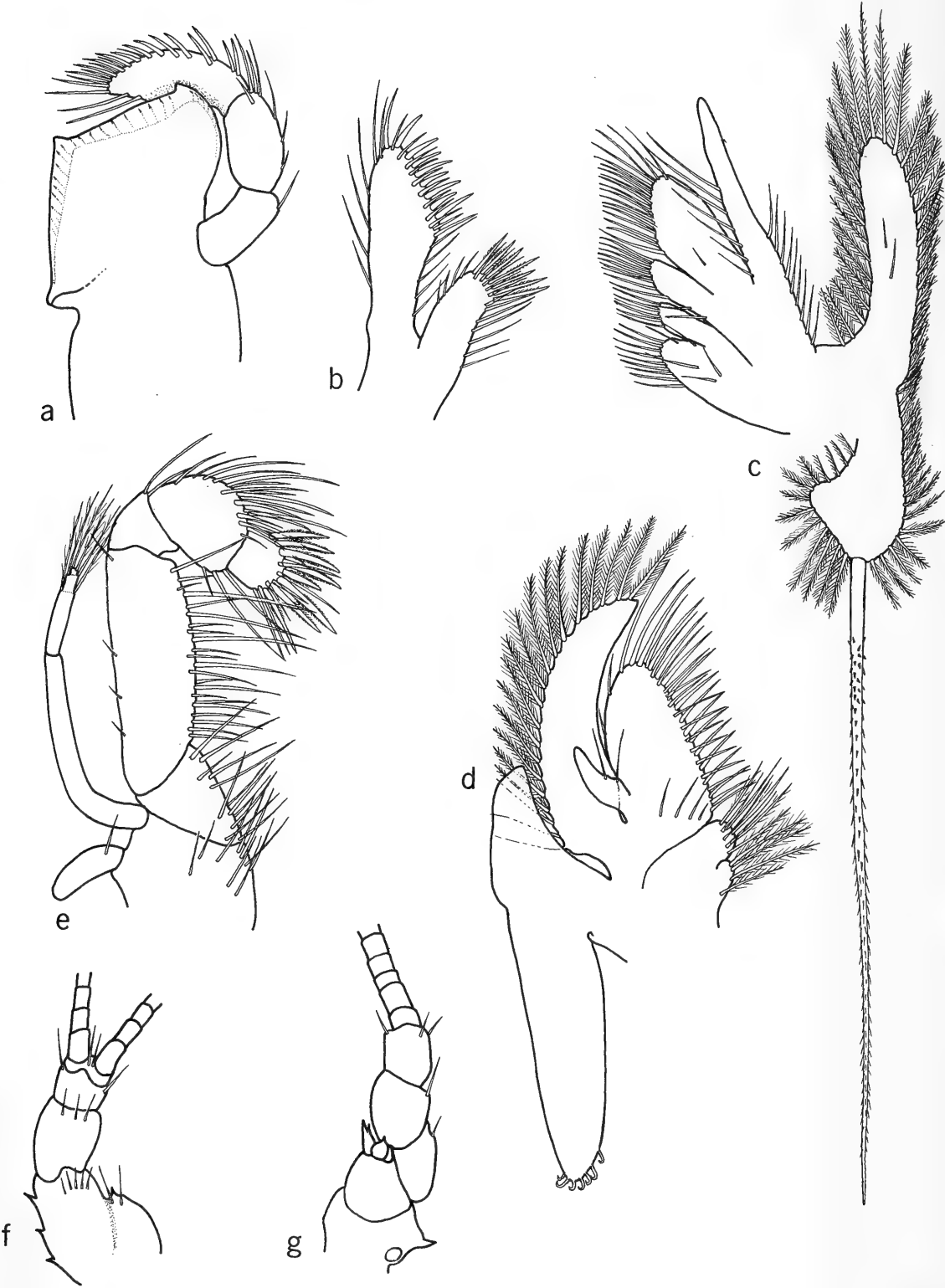


Fig. 5. *Coralaxius abelei*: a, Mandible; b, Maxillule; c, Maxilla; d, Maxilliped 1; e, Maxilliped 2; f, Antennular peduncle; g, Antennal peduncle.

Mandibular palp 3-segmented, 2 basal segments subequal in length, terminal segment somewhat longer, armed with simple marginal setae; cutting edge with straight hyaline border, short triangular tooth at outer and inner distal angles.

Maxillule bilobed, endopod lacking, basal endite armed with simple spines and setae, coxal endite tipped with fringed spines. Maxilla well developed, endopod present, basal and coxal endites bilobed, heavily armed with numerous setae and spines; scaphognathite as illustrated, posterior lobe bearing elongate modified seta armed with tiny spinules proximally, becoming setulose distally. Maxilliped 1 bearing well developed epipod, posterior lobe carrying several hooked spines; exopodal lobe elongate, endopod much reduced; basal and coxal endites armed with numerous processes. Maxilliped 2 with unbranched epipod; exopod distally setose, endopod heavily setose and spinose, terminal segment bearing fringed spines. Maxilliped 3 with unbranched podobranch plus epipod and 2 arthrobranchs; endopod pediform, outer 5 segments densely setose ventrally and mesially, with long translucent setae; coxa with tuft of setae plus single large spine mediodistally, basis similarly armed, ischium and merus with row of several spines along inner margin, merus with additional spine at outer distal angle, carpus with large spine at inner distal angle, dactyl with same at tip; exopod 2-segmented, unarmed, extending nearly to tip of antennal peduncle.

First pereopods large, inflated, chelate, asymmetrical; larger robust, smaller more scissorslike, both heavily covered with numerous large teeth, spines, and sharp or rounded tubercles; merus thin, flattened, armed on medial margin with about 10 large, forward-directed spines, increasing in size distally, with interspersed translucent setae; posterior margin noticeably dentate, more spinulose; carpus about half meral length, inflated, armed dorsomedially and posteriorly with irregular rows of acute spines, largest at dorsodistal margin, and outer distal angle. Smaller chela slightly shorter, much narrower than larger chela; elongate, outer surface of hand with numerous large and small, forward-directed, blunt or sharp tubercles, placed generally in 3 longitudinal rows; dorsal margin a thin, crenulate crest formed by connected blunt, inwardly-curving teeth; inner palm with scattered curved spinelike teeth and larger tubercles, 5 long, translucent setae extending from oblique posterior row of spines; similar row of setae along inner ventral margin, arising from bases of acute curved teeth delineating ventral margin of palm and fixed finger; fingers up to twice as long as palm, tips curved inward, meeting along entire length except for small gape near articulation; outer surface of fixed finger with 2 rows of elongate, thin, knifelike tubercles, cutting edge irregularly dentate, with 3 long, thin, fanglike spines, curving outwardly and over upper outer margin of dactyl; inner surface with longitudinal row of small, blunt teeth extending to finger tip; dactyl with high, thin longitudinal crest formed by series of about 9 sharp

inwardly-curving, connected teeth; thin rounded ledge with series of blunt teeth paralleling those on both outer and inner surfaces; second series of subacute tubercles along lower inner margin of dactyl; immediately above latter, 9 elongate, translucent setae curving down and inwardly over gape, meshing with lower setae on propodus with fingers closed. Larger chela robust, inflated proximally, thinning distally; outer surface of hand armed with numerous, thick, rounded or subacute, raised tubercles, those on lower margin and near gape more acute, directed obliquely forward; dorsal margin a crenulate crest of inwardly-curving tubercles; inner palm covered with small, pustular tubercles and spinules; row of thin, translucent setae extends from lower inner margin of palm upward toward dactylar-propodal junction, this area distinguished by large, blunt white tooth in some specimens; fingers short, about equal to or shorter than length of palm, curved inward, upper tip crossing over lower, meeting along entire length, without gape; outer surface of fixed finger with irregular row of elongate tubercles; cutting edge bluntly dentate in addition to 2 large rounded teeth; inner surface with several small, elongate blunt teeth; dactyl with superior dorsal crest formed by overlapping platelike teeth; inner surface flattened, smooth, with scattered tubercles and long, translucent setae as in minor chela; outer surface with rough, longitudinal ridge formed by irregularly fused, blunt tubercles, becoming thin rounded ridge distally toward finger tip; cutting edge irregularly dentate, with 3 large teeth proximally at propodal junction.

Second pereopod chelate, more or less flattened, almost reaching distal margin of carpus of pereopod 1. Ischium with distoventral spine; merus thin, anteriorly with 3 or 4 unequal ventral spines, plus another at posteroventral angle; carpus somewhat expanded, dentate dorsal crest supporting long, translucent setae, single strong ventral spine; hand inflated, with dentate, setose dorsal crest, plus crenulate ridge on outer surface at dactylar junction; fingers slightly longer than palm, serrate on cutting edges, upper tip crossing over lower, without gape; fixed finger with several large teeth along ventral margin; dactyl with dentate crest bearing translucent setae.

Pereopods 3 and 4 generally flattened, subequal in length; ischia with rectangular lobe on ventrodiscal margin; pereopod 3 merus similar to that of pereopod 2, but 3 ventral spines on posterior margin instead of anteriorly, lacking spine on posteroventral angle; carpus unarmed, about half length of propodus; propodus with 7–9 ventral spinules plus 2 larger spines at distoventral angle; dactyl  $2/5$  length of propodus, with 5 movable spinules, biunguiculate.

Pereopod 4 merus and carpus unarmed; propodus with 6 or 7 ventral spinules, plus 3 elongate fringed spines and thick tuft of setae posteriorly at distoventral angle; dactylus half length of propodus, otherwise similar in armature to pereopod 3; biunguiculate.

Pereopod 5 shortest, more cylindrical than preceding, reaching to about

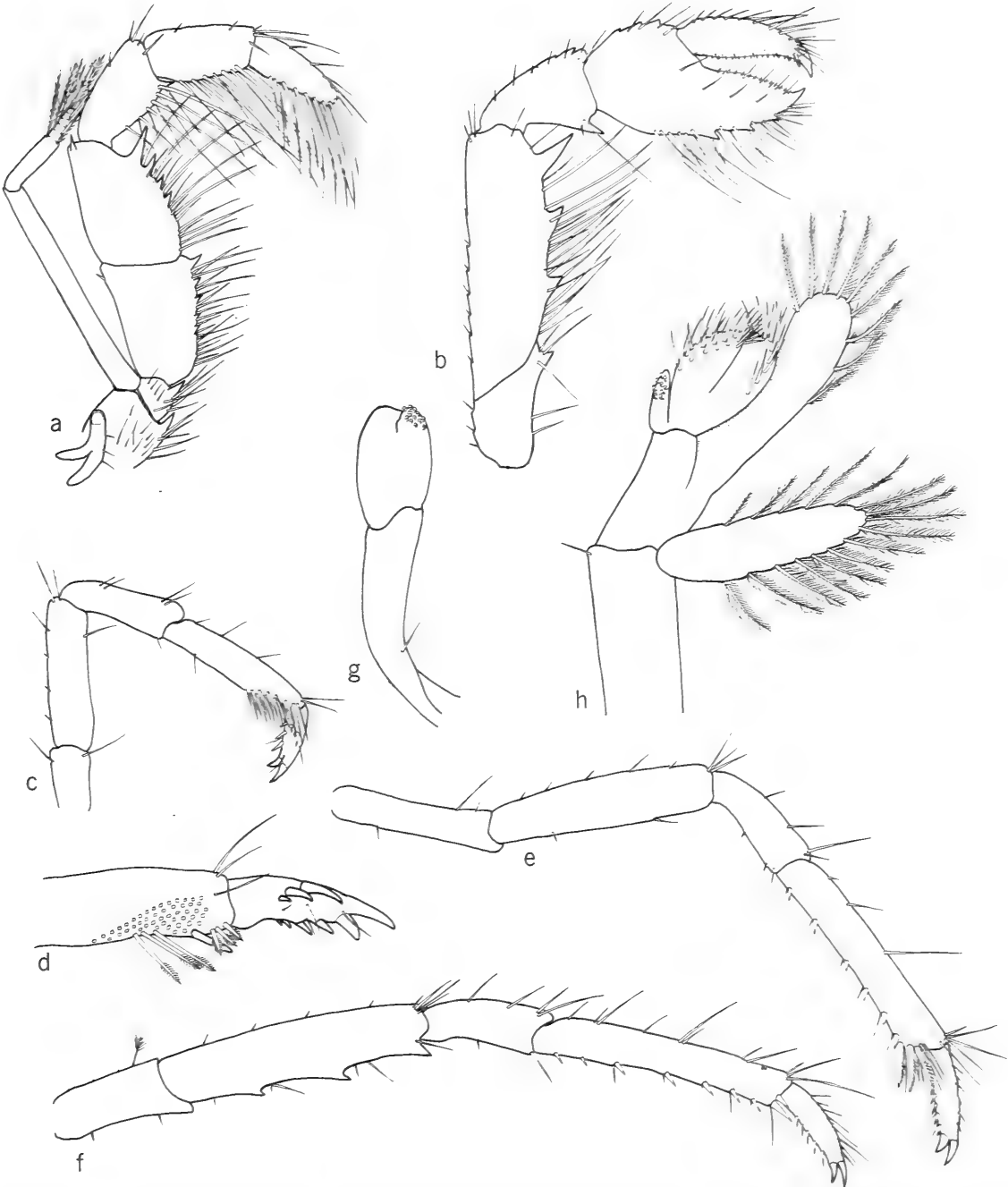


Fig. 6. *Coralaxius abelei*: a, Maxilliped 3; b, Pereopod 2; c, Pereopod 5; d, Pereopod 5, distal propodus (some spines removed) and dactylus; e, Pereopod 4; f, Pereopod 3; g, Pleopod 1 ♂; h, Pleopod 2 ♂.

end of carpus of pereopod 4, all segments unarmed except propodus, latter bearing ventrodistal cluster of simple spines, and distoventral tuft of setae more elongate than preceding leg; dactylus slightly less than half propodal length, biunguiculate, with 2 ventral and 2 lateral spinules. Pereopods 1–4 each with 2 arthrobranchs, gills absent from pereopod 5.

Large sternal plate situated between coxae of pereopods 3 and 4; anterior process smaller, raised, appearing inversely cordate, strongly bifurcate, with 2 pronounced median ridges coalescing anteriorly into point; posterior process much larger, similarly shaped, with bifurcation less pronounced, developed posteriorly into 2 inflated lobes meeting with deep medial cleft.

Pleopods on somites 1 through 5; those on somite 1 uniramous in female, bilobed in male, remaining pleopods biramous in both sexes, longer endopods of each with appendix interna. Male pleopod 1 2-segmented, distally spatulate, distal inner marginal lobe with about 12 tiny hooked spines (reduced stylamblys); pleopod 2 endopod with short cylindrical appendix interna bearing several tiny hooked spines, appendix masculina broad, bilobed, armed with numerous simple distal spines.

Tail fan heavily spinose/setose, number and position of spines somewhat variable. Uropodal exopod with 2–4 spines on outer margin, larger movable spine at transverse suture; latter with 5–7 heavy spines of varying size; dorsal surface with 2 distinct, rounded longitudinal ridges, outer bearing 2–4 spines, inner unarmed; uropodal endopod with single dorsal ridge medially, bearing 4 spines plus spine on endopodal margin; no transverse suture. Telson armed with 2 proximal spines terminating submedial carinae, 2 distal spines terminating intermedial carinae, 2 marginal spines on each side; posterior margin with 5 movable spines, longest submarginally at posterolateral angle; series of stiff setae on posterolateral margin from level of second marginal spine distally to posterolateral angle; 4 or 5 short setae on each side of posterior median spine, superior to elongate marginal setae; several long setae arising from dorsal surface of telson at or between bases of dorsal spines.

*Color.*—The specimens from Carrie Bow Cay when alive were blood red, with the legs and antennal and antennular flagella having alternating red and white bands. The Florida specimen when received was overall light ochreous yellow, overlain with a marbled pattern of cadmium yellow on the cephalothorax. The antennular and antennal flagella were irregularly banded with dark reddish-purple. Tubercles, sharp spines, and the superior crests on either hand of the first chelipeds were variously red, reddish-brown, reddish-tan, or shining white. The elongate translucent setae on the meri of pereopods 1 and 2, as well as on the telson, appeared clear golden under the microscope. Eye corneas were black. These colors, with the exception of the banding on the sensory flagella, have almost completely faded in alcohol.

*Remarks.*—*Coralaxius abelei* is immediately distinguishable from all other western Atlantic axiids by a combination of morphological characters. These include the short, sharp rostrum, the reduced, trispinose antennal acicle, the corona of gastric spinules, the lack of submedian and lateral carinae on the gastric region, by the armature of fanglike spines on the



minor cheliped, the heavy spinous and tuberculate armature on both hands of pereopod 1, by the reduced gill formula (Table 1) and by the shape of the male second pleopod. From a perusal of the literature, it seems possible that the minor cheliped of the first pereopod may eventually assume greater taxonomic importance when genera of the group are subsequently redefined. Certainly, the species described here is distinct from all other axiids in this respect.

*Sexuality*.—Some axiids exhibit hermaphroditism, but the specimens of *C. abelei* gave no indication of such. The males all possessed an appendix masculina, the females ovipores on the coxae of the third pereopods. The presence in females of a small pair of uniramous pleopods on the first abdominal somite is also easily discernible. The latter feature, however, is not always restricted to females in other axiid genera. For example, according to de Man (1925), *Axiopsis* (*Paraxiopsis*) *brocki* males may have rudimentary first pleopods, but are distinguished by the appendix masculina on pleopod 2; females have uniramous first pleopods and ovipores on pereopod 3 coxae. *Axiopsis* (*Paraxiopsis*) *bisquamosa* males lack first pleopods, possess an appendix masculina, while the females bear uniramous first pleopods and the usual ovipores. The female gonopores were not described for either species. In *Coralaxius*, the male first pleopod is simple, but is certainly not rudimentary.

The situation is more variable in *Calocaris* and *Calastacus*. Boesch & Smalley (1972) noted the presence of uniramous pleopods on the first abdominal somite of *Calocaris* (*Calastacus*) *hirsutimanus*, but stated that all five of their specimens were males, based on the presence of an appendix masculina on pleopod 2. Williams (1974) found uniramous pleopods only in (apparently) functional females of *Calocaris* (*Calastacus*) *jenneri*; the males of that species, and those of *C.* (*Calastacus*) *oxypleura*, lacked pleopods on the first abdominal somite. St. Laurent (1972) described as an hermaphroditic male the new species *Calastacus laevis*, which had a modified uniramous first pleopod, no appendix masculina on pleopod 2, easily observed gonopores on the coxae of both pereopods 3 and 5, and (based on remnants of ovulatory membranes on the pleopods) had apparently been ovigerous shortly before its capture. Clearly, there is substantial variation in regard to this feature within the genera as presently defined in the Axiidae.

*Ecology*.—The Belize specimens inhabit living coral, especially species of *Porites*, living on the outer slope of the barrier reef off Carrie Bow Cay. The Florida specimen inhabited a crevice in a piece of coralline limestone rock collected from a bottom of coralline rubble and shell hash, with localized dense algal cover. The depth range for the species extends from 11–76 m.

The long, forward-directed setae along the lower margins of the meri of the first and second chelipeds, and the basketlike effect produced by similar



Table 1.—Comparison of morphological characters in type-species of selected genera and subgenera in the Axiidae.

	Axiopsis				Coralaxius
	Calocaris	Calastacus	(Axiopsis)	(Paraxiopsis)	
Type-species	<i>C. macandreae</i> Bell, 1853	<i>C. stilirostris</i> Faxson, 1893	<i>A. (A.) serratifrons</i> (A. Milne Edw., 1873)	<i>A. (P.) brocki</i> (de Man, 1888)	<i>C. abelei</i> , sp. nov.
Rostrum	Triangular, margins dentate	Styliform, margins unarmed	Triangular, margins dentate	Triangular, margins dentate	Triangular, margins unarmed
Carapace	Keeled to posterior border	Not posteriorly keeled	Not posteriorly keeled	Not posteriorly keeled	Not posteriorly keeled
Eyestalk:rostrum	Rostrum longer than eyestalk	Rostrum longer than eyestalk	Rostrum equal or slightly longer than eyestalk	Rostrum longer than eyestalk	Rostrum shorter than eyestalk
Eyes	Unpigmented	Unpigmented	Pigmented	Pigmented	Pigmented
Acicle	Short	Long	Long	Short	Short
Chelipeds (First pair)	Unequal; fingers longer than palm	Symmetrical; fingers shorter than palm	Unequal; fingers shorter than palm	Unequal; fingers shorter than palm	Unequal; fingers longer or shorter than palm
Pleopod 1	Single lobe, no stylamblys	Bilobed, subspatulate; no stylamblys	Absent	Rudimentary, no stylamblys	Bilobed, reduced stylamblys
Pleopod 2					
Appendix masculina	Absent	Absent	Rod-shaped	Rod-shaped	Broad, bilobed
Appendix interna	Short Hermaphroditic	Reduced Not hermaphroditic	Slender, thin Not hermaphroditic	Absent Not hermaphroditic	Rod-shaped Not hermaphroditic
Telson	With spinose dorsal keels	Without spinose dorsal keels	With spinose dorsal keels	With spinose dorsal keels	With spinose dorsal keels
Pereopods 3-5 dactyls	Simple	Simple	Simple	Simple	Biunguiculate

setae on the fingers of the major chelipeds, suggest that *C. abelei* uses such setae either as a mechanical or sensory aid, perhaps by shovelling and sifting through benthic detritus as it moves along the bottom. The large, fanglike spines on the minor cheliped also suggest a carnivorous habit. The rocky, limestone habitat seaward of a large, deep, coral bioherm is a biotope that has been little sampled by conventional trawling and dredging gear from the surface. Further collections by SCUBA or submersible may produce more specimens and concomitant observations on their ecology.

*Discussion.*—*Coralaxius* shares with the subgenus *Paraxiopsis* several characters which allow both taxa to be distinguished from other genera and subgenera. This combination includes 1) the transverse suture on the uropodal exopods; 2) the reduced antennal acicle; 3) the pigmented, well-developed eyes; and 4) the depressed gastric region of the cephalothorax (*fide* de Man 1925). The absence of a median dorsal keel on the posterior carapace surface is also a character shared by *Coralaxius* and *Paraxiopsis*, and may remain a valid character within both these taxa, although Boesch & Smalley (1972), and Williams (1974) deprecate its taxonomic value in the closely related *Calocaris* and *Calastacus*. There remains much uncertainty, however, regarding the limits of these genera and subgenera, with *Calocaris* (*Calocaris*), *Calocaris* (*Calastacus*), *Axiopsis* (*Axiopsis*), and *Axiopsis* (*Paraxiopsis*) being defined on characters which for the most part are exclusive, but which also seem to be shared by 1 or 2 species within each taxon (see Tables 1 and 2). Boesch & Smalley, for example, point out that the similarities between some members of *Calocaris* (*Calastacus*) and *Axiopsis* (*Axiopsis*) are greater than those between the former taxon and the nominate subgenus of *Calocaris*. Recently St. Laurent (1972), in describing a new species of *Calastacus*, provided an emended diagnosis and re-established the genus *Calastacus*, *sensu* Faxon (1893). However, in applying her emended definitions and thereby separating the genera *Calocaris* and *Calastacus*, only 2 of the 9 species known at that time could be relegated to *Calastacus*. The remaining 7 species of *Calocaris* (*Calastacus*) *s.l.* plus the 2 subsequently described by Williams (1974), await the establishment of one or more new genera, if St. Laurent's revision is to be accepted.

The subgenus *Axiopsis* (except *A. (A.) habereri* Balss) is at present separated from *Calocaris/Calastacus* chiefly by the absence of a postcephalic-groove carina on the cephalothorax. Unfortunately, *Calocaris* (*Calocaris*) *aberrans* Bouvier also lacks this carina, thus differing from other members of its genus. *Axiopsis* (*Axiopsis*) differs from *A. (Paraxiopsis)* in possessing an elongate, well-developed antennal acicle, a character which also distinguishes species of *C. (Calastacus)* from *C. (Calocaris)*. It is clear that these genera and subgenera have been established using ambivalent morphological characters, a fact long noted by students of the family, including de Man himself (1925).

Table 2.—Branchial formulae in selected genera and subgenera of the family Axiidae.

	Maxillipeds			Pereopods				
	1	2	3	1	2	3	4	5
<i>Calocaris macandreae</i> *	—	E + 1	E + 1	E + 1	E + 1	E + 1	E	—
Arthrobranchs	—	1	2	2	2	2	2	—
<i>C. macandreae</i> †	E	O + 1	O + 1	E + 1	E + 1	E + 1	E	—
Arthrobranchs	—	1	2	2	2	2	2	—
<i>Calastacus stilirostris</i> (Faxon, 1893)	—	E	E + 1	E + 1	E + 1	E + 1	E	—
Arthrobranchs	—	—	2	2	2	2	2	—
<i>Axiopsis</i> (A.)	—	E + 1	E + 1	E + 1	E + 1	E + 1	E	—
Arthrobranchs	—	—	2	2	2	2	2	—
<i>A. (Paraxiopsis)</i>	—	E + 1	E + 1	E + 1	E + 1	E + 1	E + 1	—
Arthrobranchs	—	—	2	2	2	2	2	—
<i>Coralaxius abelei</i>	—	E	E + 1	—	—	—	—	—
Arthrobranchs	—	—	2	2	2	2	2	—

\* Data from St. Laurent, 1972.  
† Data from Ortmann, in Faxon, 1893.

Although creation of subgenera within the family Axiidae serves to indicate close relationships, the characters presently used (as noted by St. Laurent, 1972) may eventually prove to be superficial, or of such variability within populations of shrimp as to be practically without value. In her comparison of *Calocaris* and *Calastacus*, for example, St. Laurent (1972:353) defined *Calocaris macandreae* as possessing symmetrical chelipeds. However, a specimen of this species from the Firth of Clyde (USNM 19614) shows unequal chelae. Squires (1965:7) in describing the closely related *Calocaris templemani*, noted that in this species, as well as in *C. macandreae* "both chelae of the first pereopods in the same species are essentially similar but may be slightly unequal in some." Thus, a prerequisite to taxonomic stability in the family is evaluation of several morphological features presently shared at both the generic and subgeneric levels.

*Etymology*.—The species is named for Dr. Lawrence G. Abele, noted carcinologist and esteemed colleague.

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We thank Mr. Ron Larson, formerly of the Smithsonian Institution, the Office of Coastal Zone Management, NOAA, Washington, D.C., and Dr. Robert S. Jones, Science Director, Harbor Branch Foundation Laboratory, Ft. Pierce, Florida, for providing collections containing the new species. We also extend our thanks to Drs. Fenner A. Chace, Jr., and Raymond B. Manning, National Museum of Natural History, and Austin B. Williams, National Marine Fisheries Service, Systematics Laboratory, NMNH, Washington, D.C., for providing literature concerning the new species, and critically reading an earlier draft of the manuscript.

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*RIFTIA PACHYPTILA*, NEW GENUS, NEW SPECIES,  
THE VESTIMENTIFERAN WORM FROM THE  
GALÁPAGOS RIFT GEOTHERMAL  
VENTS (POGONOPHORA)<sup>1</sup>

Meredith L. Jones

*Abstract.*—*Riftia pachyptila*, new genus, new species, is described from geothermal vents of the Galápagos Rift and from a geothermal area on the East Pacific Rise at 21°N. These vestimentiferan worms represent a new family, Riftiidae, in a new subphylum, Obturata, in the phylum Pogonophora. Differentiation from the two other vestimentiferan species is at the familial level and concerns the orientation of tentacular lamellae on the obturaculum, the number of openings of excretory ducts, and the relative lengths of certain body regions. A most curious structure, the trophosome, occupies much of the trunk region and is essentially a vascularized, bacteria-filled sac; it is also the site of deposition of crystals of elemental sulfur.

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In 1966 specimens of a worm, *Lamellibrachia barhami* Webb, were collected off the coast of California at a depth of 1,125 m. These animals, designated as a new class of Pogonophora by Webb (1969a), have subsequently been the object of continuing detailed research by him (Webb, 1969b, c, 1971, 1975, 1977). Inclusion in the Pogonophora was based “. . . primarily on the shape, structure, and protein content of the tube,” as well as “. . . distinctive pogonophoran characters: the very long trunk region, the metasoma, and the absence of a gut” (Webb, 1969a, p. 41). Webb’s new pogonophoran class, Afrenulata, was characterized merely by the lack of a bridle (frenulum), while his new order, Vestimentifera, was erected on the basis of: 1. Simple paired excretory ducts, without connections with the tentacular coelom, which open exteriorly by a single median excretory pore at the base of the “tentacular crown”; 2. An undifferentiated trunk, provided with papillae; 3. A tentacular crown formed of numerous fused tentacles surrounding a paired, centrally placed “lophophoral organ,” which is in turn surrounded by a number of tentacular sheaths; 4. A so-called vestimental region between the tentacular crown and the trunk, provided with lateral folds which meet to form a vestimental chamber between the vestimentum and the tube; and 5. Genital apertures which open into the

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<sup>1</sup> Contribution No. 8 of the Galápagos Rift Biology Expedition, supported by the National Science Foundation.

vestmental chamber, with male apertures provided with ciliated grooves. A second collection of *L. barhami* was reported by Webb (1977) from off the coast of Oregon.

In 1970 a second species of vestimentiferan was collected from a depth of 500 m on the continental slope off Guyana. *Lamellibrachia luymesii* van der Land and Nørrevang was described from a single male specimen, and has been reported upon in two papers (van der Land and Nørrevang, 1975, 1977). Specific differences between *L. barhami* and *L. luymesii* cited by van der Land and Nørrevang (1975) were: 1. The relative length of the vestimental region; 2. The number of tentacular sheaths; 3. The relative proximity of male genital apertures; 4. The structure of the tube; and 5. The presence of various grooves and lines of pigment on certain parts of the trunk and vestimentum.

The descriptions of the two species of *Lamellibrachia* point up a continuing controversy concerning the dorso-ventral orientation of the Pogonophora. On the one hand Webb considers the nerve cord to be dorsal, while van der Land and Nørrevang assume that it is ventral; the former view implies a relationship to the hemichordates *et al.*, and the latter, to the annelids. Three sets of neutral terms have been suggested: "neural" and "tentacular," "neural" and "antineural," "adneural" and "antineural," (Southward, 1975a, b; Anon., 1975, p. 143, respectively). In this paper I decline to use the neutral terms of orientation, for there is no unequivocal distribution of tentacles in the vestimentiferans and, while "neural," "adneural," and "antineural" are unequivocal, I find them awkward and I suspect that they may be susceptible to confusion. As will be noted below, it is my opinion that the vestimentiferans, as well as the Pogonophora, stand in close relationship to the Annelida and I follow van der Land and Nørrevang in considering the nerve cord to be ventral and the major blood vessel, provided with a thick muscular layer, to be dorsal.

In 1977 and 1979 during expeditions to the Galápagos Rift and East Pacific Rise areas the submersible *Alvin* obtained a number of vestimentiferans which are the subject of this paper. At the Galápagos sites, water coming from geothermal vents may be as warm as 23°C and may contain hydrogen sulfide to the extent of 160  $\mu$ mole per liter, and, at temperatures above 10°C, the vent waters are anoxic; ambient temperature of bottom water near the vents is about 2°C, it is oxygenated, and there is no hydrogen sulfide present (Corliss *et al.*, 1979). A total of 63 worms, collected at three geothermal vents in the Galápagos Rift area and one vent on the East Pacific Rise, have been deposited in the collections of the Division of Worms, National Museum of Natural History (USNM), Smithsonian Institution, and these form the basis for the following description. Paraffin sections were cut at 5  $\mu$ m and stained with routine staining procedures indicated below. The identity of sulfur crystals was confirmed by an ARL-SEMQ electron microprobe

and by X-ray diffraction utilizing CuK X-radiation (nickel-filtered) with a Gandolfi 114.6 mm camera and a polycrystalline sample.

### Riftiidae, new family

*Type-genus*.—*Riftia*, new genus.

*Diagnosis*.—Vestimentiferans with tentacular lamellae at right angles to obturaculum; without tentacular sheaths; obturaculum at least 11% of total length; with separated, paired, external openings of excretory ducts; with essentially cylindrical tube.

### *Riftia*, new genus

*Type-species*.—*Riftia pachyptila*, new species.

*Gender*.—Feminine.

*Diagnosis*.—Characters of the family (above).

*Etymology*.—From Danish and Norwegian, *rift* (rent, fissure) + *-ia*, in reference to the Galápagos Rift.

### *Riftia pachyptila*, new species

Figs. 1–4

Worm(s).—Ballard, 1977:41, 43 (with fig.).—Anon., 1979:11 (with fig.).—The Editor, 1979:680, 681 (fig.).—Ballard and Grassle, 1979:689 (with fig.).—Schlee, 1979:41.

Tube worm(s).—Corliss and Ballard, 1977:441 (with fig.), 449.—Corliss *et al.*, 1979:1079.—Schlee, 1979:42 (with fig.).—The Editor, 1979:688.—Ballard and Grassle, 1979:699 (with fig.), 705 (fig.).—RISE Project Group, 1980:1421, 1432.

Pogonophora(ns).—Corliss and Ballard, 1977:441 (with fig.).—Corliss *et al.*, 1979:1075, 1079–1080, figs. 4, 5.

Vestimentifera(ns).—Corliss *et al.*, 1979:1079.—Ballard and Grassle, 1979:689 (with fig.).—Galápagos Biology Expedition Participants, 1979:6 (with fig.), 7, 8.—Jannasch and Wirsén, 1979:592, 594–595.—RISE Project Group, 1980:1424, fig. 5.—Hekinian *et al.*, 1980:1435.—Terwilliger *et al.*, 1980:531 *et seq.*

*Diagnosis*.—Characters of the family (above).

*Etymology*.—From Greek, *pachys* (thick) + Greek, *ptilon* (feather), in reference to the aspect of the anterior plume of the worm (combination treated as an adjective).

*Type-locality*.—“Rose Garden” geothermal vent (RG), Galápagos Rift (00°48'15"N; 86°13'29"W), 2,450 m depth.

*Other localities of paratypes*.—Galápagos Rift—“Dandelions” geothermal vent (D) (00°47'42"N; 86°08'00"W), 2,496 m depth; “Garden of Eden”



geothermal vent (GE) (00°47'42"N; 86°07'44"W), 2,485 m depth. In addition, worms have been noted, but not collected, at "Mussel Bed" geothermal vent (00°48'06"N; 86°07'00"W), 2,490 m depth. East Pacific Rise geothermal vent (EPR) (20°51'00"N; 109°04'54"W), 2,595 m depth.

*Material examined.*—Holotype (USNM 59951), RG, *Alvin* Dive (AD) 889, 14 Feb 1979, adult female. Paratypes: 1 adult, D, AD 723, 27 Feb 1977; 1 sectioned adult (USNM 59953), 1 sectioned juvenile (USNM 59954), 8 adults and juveniles (USNM 59955), GE, AD 733, 16 Mar 1977; 3 adults (USNM 59956), GE, AD 884, 25 Jan 1979; 1 adult (USNM 59957), 1 sectioned young adult (USNM 59958), 1 young adult (USNM 59959), 3 sectioned juveniles (USNM 59960–62), 7 juveniles (USNM 59963), RG, AD 889, 14 Feb 1979; 1 adult (USNM 59964), EPR, AD 915, 22 Apr 1979; 2 adults (USNM 59965), RG, AD 983, 30 Nov 1979; 2 adults (USNM 59966–67, RG, AD 984, 1 Dec 1979; 1 adult (USNM 59968), RG, AD 988, 5 Dec 1979; 1 adult, 1 young adult (USNM 59969), 1 adult, 1 young adult, 1 juvenile (USNM 59970), 1 adult, 2 young adults (USNM 59971), 1 adult, 1 juvenile (USNM 59972), 7 adults (USNM 59973–79), RG, AD 990, 7 Dec 1979; 1 adult, 2 young adults (USNM 59980), 2 adults (USNM 59981–82), GE, AD 993, 10 Dec 1979. Non-Types: 2 empty tubes (USNM 59996–97), GE, AD 983, 30 Nov 1979; 1 empty tube (USNM 59998), RG, AD 990, 7 Dec 1979; 1 empty tube with adult fragment and 7 juveniles (USNM 59999), GE, AD 993, 10 Dec 1979.

*Description.*—Dimensions, relative lengths and certain meristic characters of the holotype and a representative series of paratypes are listed in Table 1.

With four body regions: (1) Anterior tentacular plume on obturaculum; (2) Winged vestimentum; (3) Trunk; (4) Segmented posterior opisthosome (terminology: Webb, 1969a; van der Land and Nørrevang, 1975, 1977) (Fig. 1B).

Central axial obturaculum of plumed region paired and fused, splayed apically (Fig. 1C); with non-ciliated dorsal groove and ventral ridge along length (Fig. 2B); with tentacular lamellae perpendicular to axis, extending nearly to anterior tip, giving impression of thick feather (Fig. 1D); paired

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Fig. 1. *Riftia pachyptila* (A: USNM 59999; B: USNM 59951; C, E: USNM 59957; D: USNM 59956). A, Tube with four young individuals attached; apical aperture, upper left; closed basal end, right center; tube cut to obtain animal; folds in tube, during initial storage/preservation, give misleading appearance to relatively uniform tube diameter; B, Overall view of holotype; C, Obturacular plume, lateral view; splayed distal end, above; D, Same, ventral view; E, Vestimentum, ventral view; BN: bifurcated ventral nerve; JU: juvenile; LT: large tentacle; OB: obturaculum; OP: opisthosome; TR: trunk; VC: ventral ciliated field; VE: vestimentum; VR: ventral ridge; VW: vestimental wing; YA: young adult. Scale bars (lower right)—A, B: 10 cm; C–E: 5 cm.

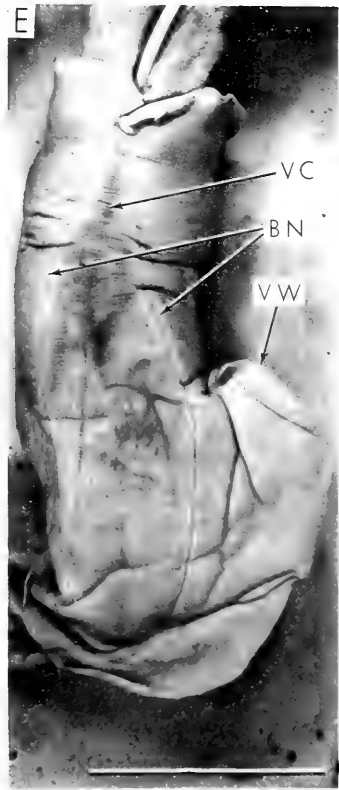
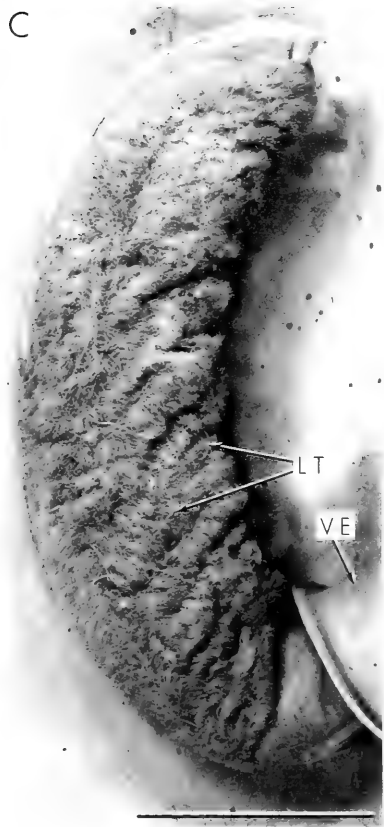
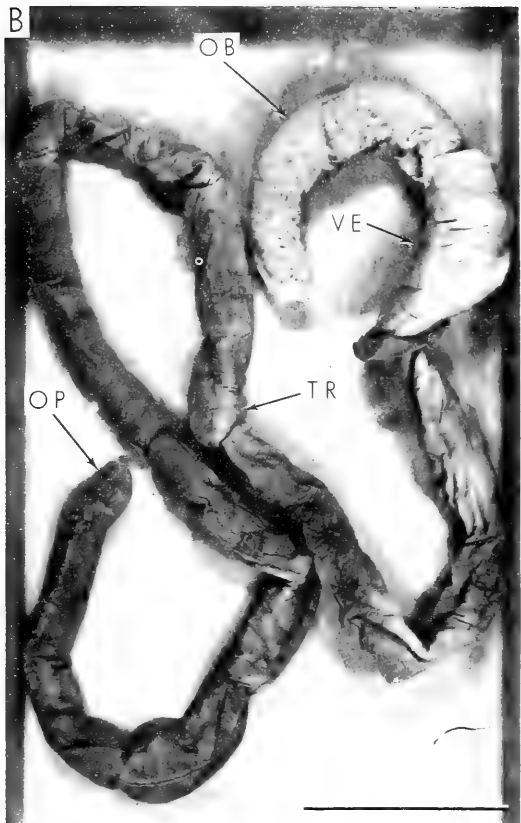
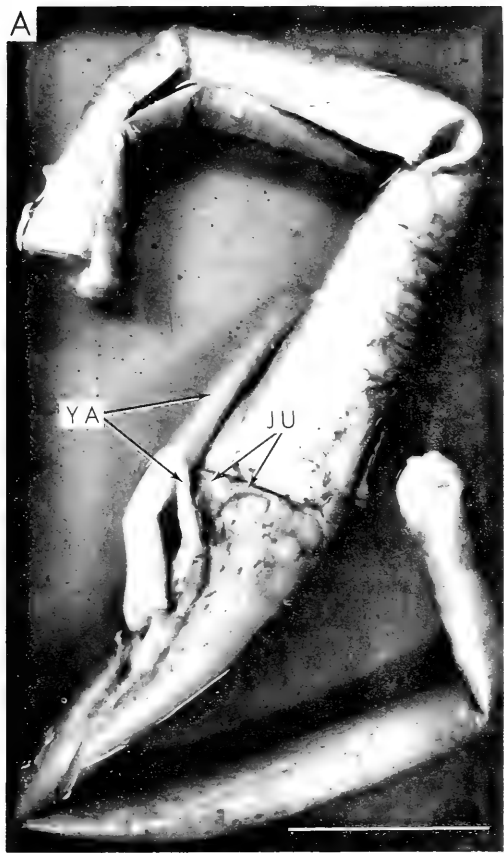


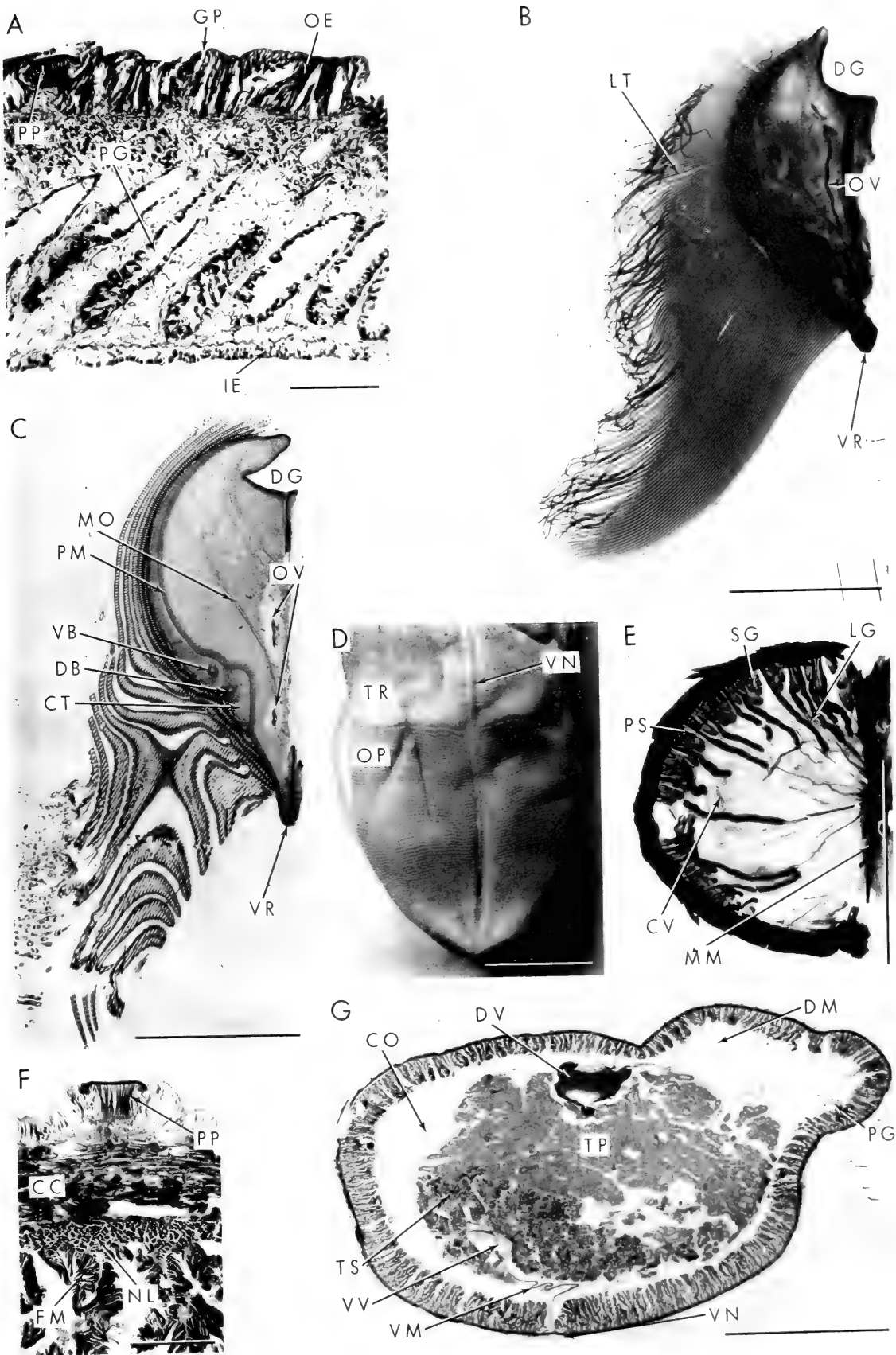
Table 1.—*Riftia pachyptila*: Comparison of specimens of various lengths showing relative lengths of obturaculum (OB), vestimentum (VE), trunk (TR), and opisthosome (OP), with numbers of paired tentacular lamellae and of opisthosomal segments.

Cat. number	Sex	Percentage body length				Total length (mm)	No. tent. lamellae	No. op. segs.
		OB	VE	TR	OP			
USNM 59951	♀	11	7	80	2	1,502.00	334	96
USNM 59957	♂	16	13	69	3	1,056.00	302	103
USNM 59964	♀	34	13	49	3	513.00	257	86
USNM 59952	♀	17	17	59	7	320.00	170	85
USNM 59955	♀	22	18	53	7	273.00	193	74
USNM 59955	♀	26	22	45	7	215.00	166	66
USNM 59959	♀	26	12	56	6	199.00	116	72
USNM 59953	♂	22	16	55	6	171.00	113	95
USNM 59959	♀	27	11	57	5	169.00	111	78
USNM 59958	♀	24	14	56	6	111.00	113	73
USNM 59959	♂	29	13	49	9	77.00	95	82
USNM 59959	♂	27	13	53	7	55.00	63	71
USNM 59954	?	34	24	30	13	15.50	39	36
USNM 59963	?	30	26	33	21	6.10	12	19
USNM 59963	?	33	22	28	17	6.00	23	25
USNM 59963	?	28	19	35	19	4.30	8	18
USNM 59960	?	28	18	34	20	1.60	1?	11
USNM 59963	?	35	17	29	19	0.75	—	2+

halves of apical split end forming operculum upon withdrawal into tube. In life vestimentum with dorsolateral flaps/wings overlapping one another within tube, with free anterior margin of flaps meeting and slightly overlapping ventrally (Fig. 1E); free posterior margin of flaps continuous and entire, ventrally (Fig. 1B, E); paired genital apertures at posterior third of dorsal

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Fig. 2. *Riftia pachyptila* (A: USNM 59958; B, C, E–G: USNM 59953; D: USNM 59951). A, Vestimental wing, transverse section; Masson's Trichrome stain; outer surface when overlapped, above; inner surface, below; B, Tentacular lamella, complete, from mid-region of obturaculum; obturaculum, upper right; Mallory's Triple stain (ML); C, Obturaculum with associated tentacular lamellae, transverse section; Chlorazol Black; D, Opisthosome, ventral view; E, Opisthosomal septum, complete, from one side (ML); F, Trunk body wall, transverse section, showing plaqued papilla; Toluidine Blue; G, Trunk, transverse section (ML). CC: circular muscle/connective tissue; CO: coelom; CT: compartmented tissue; CV: connecting vessel; DB: anterior branch of dorsal vessel; DG: dorsal groove; DM: dorsal mesentery; DV: dorsal vessel; FM: "feather" longitudinal muscle; GP: gland papilla; IE: inner epithelium; LG: "long" gland; LT: large tentacle; MM: medial mesentery; MO: muscle strands of obturaculum matrix; NL: "normal" longitudinal muscle; OE: outer epithelium; OP: opisthosome; OV: obturaculum vessel; PG: pyriform gland; PM: parasagittal muscle; PP: plaqued papilla; PS: partial septum; SG: "short" gland; TP: trophosome; TR: trunk; TS: testes; VB: anterior branch of ventral vessel; VM: ventral mesentery; VN: ventral nerve; VR: ventral ridge; VV: ventral vessel. Scale bars (lower right) A, F: 100  $\mu$ m; B, C, E, G: 5 mm; D: 10 mm.



surface in both sexes; male aperture associated with ciliated ridges, converging but not meeting anteriorly; female apertures lacking ciliated ridges; ventral ciliated field somewhat pear-shaped, delimited by paired ventral nerves and neurular tubes (Fig. 1E); papillar openings of internal pyriform glands on surface, apart from ventral ciliated field, and on outer surface of overlapped flaps (Fig. 2A); dorsal cavity formed by overlapping flaps nearly lacking such papillar openings, with cuticle, lacking specialized epithelium. Trunk with similar papillae, with united single ventral nerve and neurular tube extending throughout length (Figs. 2G, 3A). Opisthosome with variable number of segments, ending in rounded posterior tip (Fig. 2D); anterior segments (about  $\frac{1}{3}$  length), each completely encircled with paired single rows of setae, becoming incomplete posteriorly.

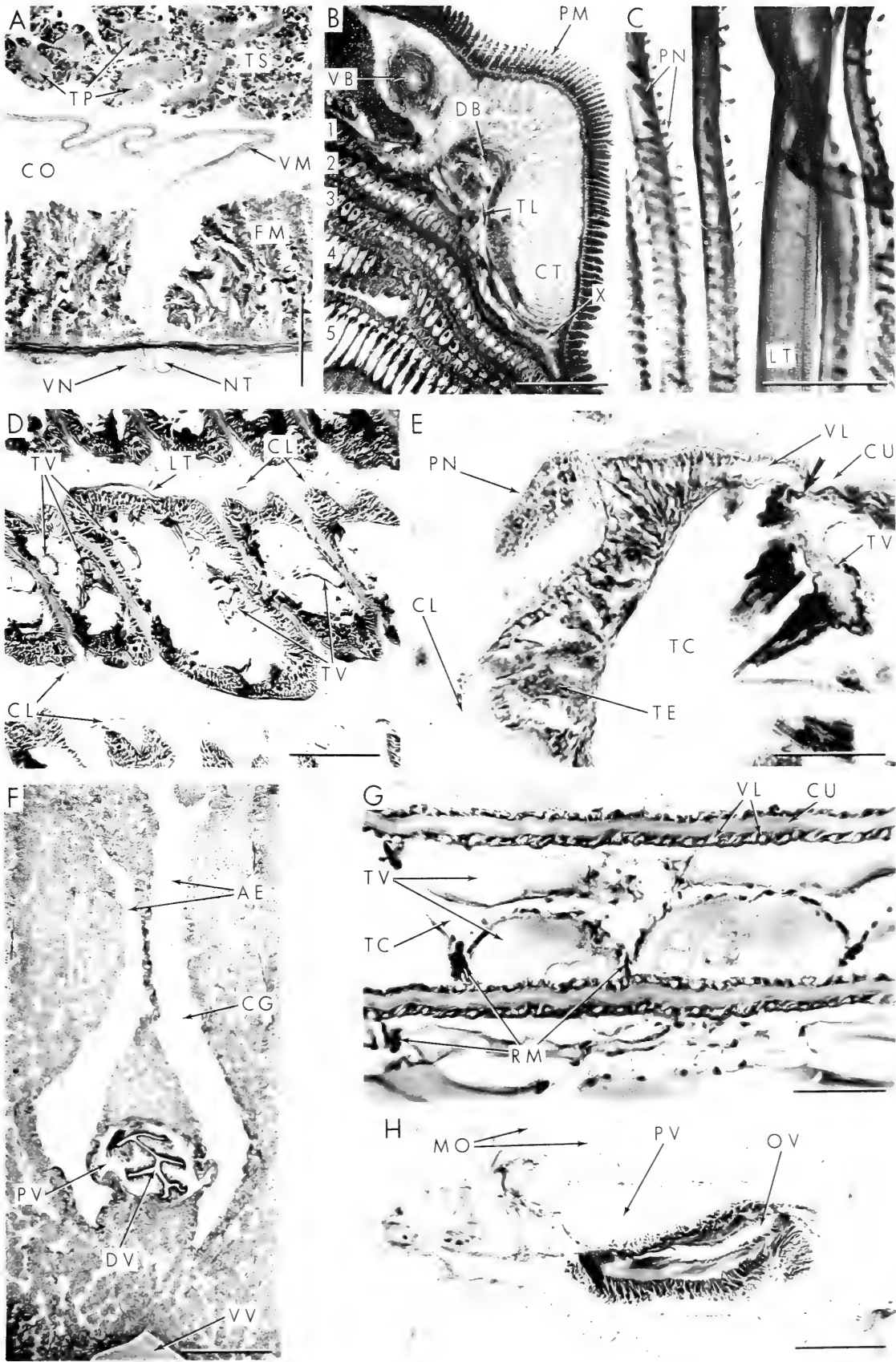
No setae on vestimentum or trunk; setae with long shafts with two toothed areas extending free of body surface; many teeth in posterior area, pointing anteriorly; fewer in anterior area, pointing posteriorly; identical with girdle setae of Pogonophora (Fig. 4B); no peg-like setae.

Papillae most numerous on outer surface of vestimental wings and on posterior trunk, progressively fewer papillae anteriorly along trunk, very few papillae on dorsal surface of vestimentum and inner surface of wings; papillae with plaques about three to five times more numerous than those without plaques, latter probably exit for secreted tube material.

Tube white, flexible, extremely sturdy, essentially cylindrical (Fig. 1A); basally blind-ending, approximate shape of opisthosome; apical opening thinning to apertural margin; main part of tube commonly 2–3 mm thick; tube material laid down incrementally forming rudimentary “collars” or

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Fig. 3. *Riftia pachyptila* (A–E, G–H: USNM 59953; F: USNM 59958). A, Trunk, ventral body wall, transverse section; Toluidine Blue; B, Compartmented tissue adjacent to obturacular matrix and basal origins of five consecutive tentacular lamellae, transverse section; Mallory's Triple stain (ML); C, Tentacles, distal free ends; Grenacher's Borax Carmine/Fast Green; D, Tentacles, fused as a lamella, cross-section (ML); E, Tentacle, free, showing connection of transverse intraepithelial loop with longitudinal tentacular blood vessel (arrow), trending toward adjacent pinnule, cross-section (ML); F, Dorsal vessel in posterior vestimentum, immature specimen, transverse section; Paraldehyde Fuchsin; G, Tentacles, fused as a lamella, longitudinal section (ML); H, Obturacular vessel in obturacular matrix, transverse section (ML). AE: anterior extension of trunk coelom; CG: coagulated coelomic fluid, CL: cilia; CO: coelom; CT: compartmented tissue; CU: cuticle; DB: anterior branch of dorsal vessel; DV: dorsal vessel; FM: “feather” longitudinal muscle; LT: large tentacle; MO: muscle strands of obturacular matrix; NT: neurular tube; OV: obturacular vessel; PM: parasagittal muscle; PN: pinnule; PV: perivascular cavity; RM: ring muscle; TC: tentacular coelom; TE: tentacular epithelium; TL: vessel from tentacular lamella “2”; TP: trophosome; TS: testes; TV: tentacular vessel; VB: anterior branch of ventral vessel; VL: intraepidermal transverse vascular loop; VM: ventral mesentery; VN: ventral nerve; VV: ventral vessel; X: site of formation of newest “compartment”; 1–5: serially more proximal tentacular lamellae. Scale bars (lower right)—A, B, F: 0.5 mm; C: 250  $\mu$ m; D, H: 100  $\mu$ m; E: 25  $\mu$ m; G: 50  $\mu$ m.



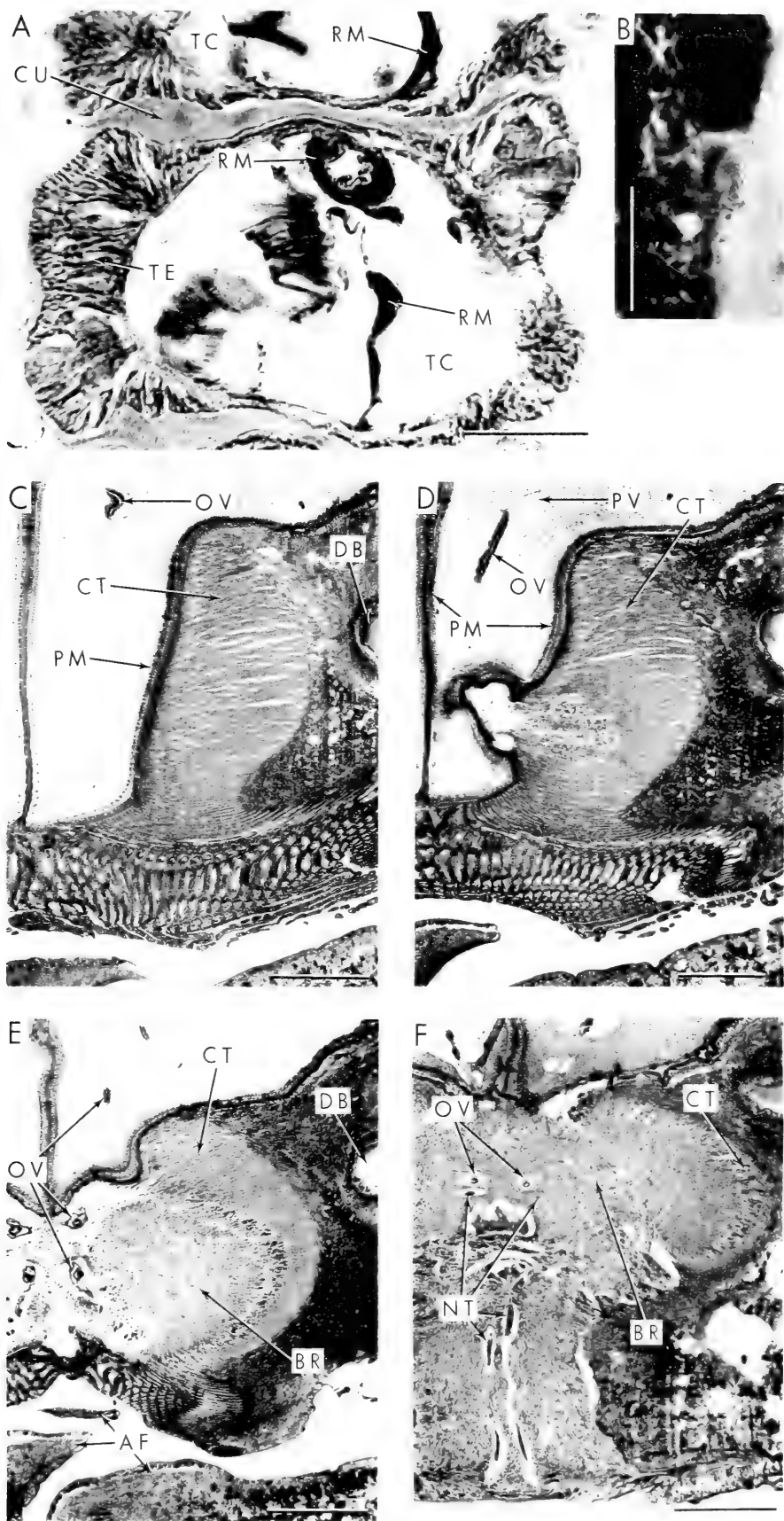


flanges; tube secretion adhering to solid materials (rocks, limpet shells) and to other tubes (Fig. 1A); in longer tubes, basal partitions separating worm's living space from unoccupied, basal, older portions (tube, presumed that of holotype, 2,654 mm long with basal end ragged, as if torn; at 1,245 mm from apical end of tube, secreted partition restricting occupant to distal portion of tube; between this partition and basal end, 11 partitions previously secreted).

Internally, obturaculum with gelatin-like, semi-solid matrix invested with thick cuticle (Fig. 2B, C); sagittal fusion of obturacular halves with double layer of cuticle; internal from cuticle as many as 500 bundles of muscles, appearing to be longitudinal, actually as many as 250 muscle rings, in parasagittal planes (Figs. 2C, 3B, 4C, D:PM); matrix penetrated by paired obturacular blood vessels, blind-ending near split anterior region of obturaculum, originating from two anterior branches of dorsal vessel in vestimental region (Figs. 2B, C, 3H, 4C–F); obturacular vessels with thin inner lining of muscle cells, then thick layer of connective tissue, surrounded externally by closely applied ring muscles (Fig. 3H); vessels supported by two mesentery-like structures in perivascular cavity, lacking connection to any other body cavity. Vestimental region quite solid with mass of muscle strands and connective tissue elements intermixed (Fig. 3F); with close-packed pyriform glands in discrete layer, opening to external surface of overlapped flaps (dorsolateral) and vestimentum, proper (lateral and ventral) (Fig. 2A); brain anteroventral, internal to ventral overlapping of flaps; ventral extension of brain tissue extending to cuticular covering of body, containing paired neurular tubes arising *de novo* in brain tissue (Fig. 4F); ventral ciliated field formed of transversely fused cilia, emerging from epithelial cells not continuously in contiguous contact, forming considerable lacunae or sinuses; dorsal surface of posterior  $\frac{1}{4}$  of vestimentum with anterior extension of trunk and its coelomic cavities overlapping, with genital ducts moving for-

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Fig. 4. *Riftia pachyptila* (A–F: USNM 59953). A, Tentacles, fused as a lamella, showing contracted ring muscle (center) and two relaxed ring muscles (above and below), cross-section; Mallory's Triple stain (ML); B, Seta in body wall of opisthosome, frontal section; Mayer's Hematoxylin-Eosin; C, Compartmented tissue near base of obturaculum, transverse section (ML); D, Same, more posterior, showing beginning of transformation of compartmented tissue; bulge to left is initiation of connection of tissue to other side; transverse section (ML); E, Same, yet more posterior, with more extensive transformation of compartmented tissue to brain tissue; connection of both halves complete; transverse section (ML); F, Brain at level of descent of nerve tissue to form ventral nerve, transverse section (ML). AF: anterior "flap" of vestimental wing; BR: brain; CT: compartmented tissue; CU: cuticle; DB: anterior branch of dorsal vessel; NT: neurular tube; OV: obturacular vessel; PM: parasagittal muscle; PV: perivascular cavity; RM: ring muscle; TC: tentacular coelom; TE: tentacular epithelium. Scale bars (lower right)—A, B: 25  $\mu$ m; C–F: 0.5 mm.





ward then dorsally to open through genital apertures; excretory organ (possibly paired) posterior and ventral to brain. Trunk with internal surface of body wall with longitudinal "feather" muscles (van der Land and Nørrevang, 1975, 1977) internal to thin layer of more conventional longitudinal muscles, in turn internal to thin layer of mixed circular muscle and connective tissue, separated by basement membrane from layer of epithelial cells covered by external cuticular layer (Figs. 2F, G, 3A); paired coelomic cavities extending throughout entire length of trunk, separated by medial dorsoventral mesenteries investing dorsal and ventral blood vessels, attached to but not investing centrally located gonad and "trophosome" (van der Land and Nørrevang, 1975, 1977) (Figs. 2G, 3A); internal broad bases of pyriform glands project centripetally between rows of feather muscles (Fig. 2G:PG). Opisthosomal segments separated internally by two-layered septa; with only "normal" longitudinal muscles, "feather" longitudinal muscles lacking; segmental cavities separated medially by dorsoventral mesentery; anterior faces of septa with two kinds of glands, short broad and long slender, histologically different from pyriform glands of vestimentum and trunk; long slender glands invested by blood vessels which interconnect with other similar vessels and move centripetally to center of septum; segments also with low, thin, multilayered circular bands of muscles forming "partial septa" (Fig. 2E); ventral nerve here, well-formed, rounded, lacking neurular tube.

Tentacles covered with cuticle of varying thickness throughout length; fused basally for from 50 to 75% of their length to form tentacular lamellae, with tips of tentacles free (Fig. 2B); with two rows of multiciliated epithelial cells, one on posteroventral face, other on anterodorsal face, extending about 90% of basal length of each tentacle (Fig. 3D); with two rows of multicellular pinnules on posterior surface of each tentacle, along distal 45% of length, not extending to tips (Fig. 3C); central tentacular coelomic (?) cavity with two blood vessels, enclosed by basement membrane of single layer of epithelial cells (Fig. 3D, G); blood vessels connected along tentacular length by transverse intraepithelial vascular loops communicating with central cavities of pinnules (Fig. 3E); no nervous tissue seen; as many as 340 tentacles per lamella and 335 lamellae on each side of obturaculum (in holotype), about  $2.28 \times 10^5$  tentacles in plume; along length of each tentacular blood vessel "O"- or "U"-shaped ring muscles appear to act as series of sphincters (Figs. 3G, 4A); in basal region of lamellae, cuticle of fused tentacular bases thickened, successive lamellae fused to one another for short distance, serially (Fig. 3B:1-5); internally, cuticular matrix disappears and blood vessels of all tentacles of a given lamella join single transverse blood vessels which join anterior axial extensions of dorsal and ventral vessels of main body (Fig. 3B: DB, VB); immediate fate of coelomic tentacular space and of presumed tentacular nerves obscured and unknown; basal contents of all tentacles of given lamella unite, and their residuum

moving centrally, forming thin layer directed posteriorly toward base of obturaculum, in company with residua of more apical tentacular lamellae (Fig. 3B: X, CT); up to three tentacles of some lamellae lacking both rows of cilia and rows of pinnules, with 50% larger diameter and up to twice length of "normal" tentacles (Figs. 1C, 2B, 3C, D).

Dorsal vessel in trunk thin-walled with thin connective tissue layer covered with thin layer of circular (?) muscles (Fig. 2G); connecting branches to trophosome, mesenterial and other vessels traversing medial mesentery; heart body (*corpus cardiacum*) in dorsal vessel in midtrunk region; anteriorly, at level of anterior extension of trunk into vestimental region, dorsal vessel with thin muscle lining, with succeeding thick layer of connective tissue, surrounded by layer of striated, circular, ring muscles, supported in perivascular cavity by thickened dorsal and ventral mesentery-like structures, whole complex supported by second dorsoventral mesentery in anterior extension of trunk coelom (Fig. 3F); more anteriorly, in vestimental region, connective tissue layer of dorsal vessel lost, wall of apparently un-oriented muscle fibers, free in perivascular cavity (mesenteries lost), trunk coelom not present; perivascular cavity surrounding dorsal vessel not connected to trunk coelom or any other coelomic cavity; just posterior to level of brain, dorsal vessel branching, each branch moving anteriorly to run length of obturaculum, ventromedially, receiving single vessels from transverse tentacular lamellar vessels (Figs. 3B, 4C, E: DB); at level of branching, dorsal vessel giving rise to paired obturacular vessels, ending blindly near anterior margin of splayed obturaculum, undergoing up to 25 dorsoventral loops through obturacular matrix (Figs. 2B, C, 3H, 4C-F). Anterior branches of ventral vessel run length of obturaculum, ventrolaterally, in company with branches of dorsal vessel, receiving branches from each transverse tentacular lamellar vessel (Fig. 3B); at base of obturaculum, posterior to level of brain, branches unite, possibly forming valve of some kind, proceeding posteriorly as single vessel embedded in loose connective tissue, with no muscular layer. Fate of anterior branches of dorsal and ventral vessels unknown—perhaps blind-ending or connecting near anterior margin of obturaculum.

Blood directly from dorsal vessel of living animals, two hours after collection, in laboratory of surface ship, of dark red color and viscosity of port wine; coelomic fluid from trunk and opisthosome of similar color and viscosity.<sup>2</sup>

Residua of tentacular lamellae moving to bases of obturacula, augmented

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<sup>2</sup> The following papers concerned with the blood of *Riftia pachyptila* have been submitted to Science, as of this writing: A. Arp and J. Childress, observations on the functional aspects of oxygenation characteristics of extracellular hemoglobin; and J. Wittenberg, R. Morris, Q. Gibson, and M. Jones, data on the kinetic constants for combination and dissociation rates of the hemoglobin.

by residua of successively more basal tentacular lamellae, forming paired ventromedial masses of narrow compartments (Figs. 3B, 4C: CT); in anterior part of vestimentum, rigid linearity of compartments breaking down and lamellar residua becoming "transformed" into brain tissue (Fig. 4D, E); just anterior to branching of dorsal and ventral vessels, "pillar" of nervous tissue with paired neurular tubes, each in own cavity, moving ventrally to just internal to cuticle, becoming flattened to form band of nervous tissue with separated neurular tubes (Fig. 4F); posteriorly, band of nervous tissue branching laterally at about 10% length of vestimentum, and area between branches of ventral nerve, ventral ciliated field (Fig. 1D, E); at about 60–70% of length of vestimentum, divergence of nerve bands (and width of ventral ciliated field) at maximum, followed by rapid convergence of nerve tissue and neurular tubes, meeting at about 85% vestimental length, at posterior margin of ventral ciliated field; ventral nerve band continuing as such, with single neurular tube, to the posterior end of trunk (Fig. 3A); in opisthosome ventral nerve changing from band-like to compact, rounded cord, lacking neurular tube, proceeding to basal end of opisthosome (Fig. 2D).

Presumed excretory organ just posterior to brain at level of branching of dorsal and ventral vessels; main mass of ciliated tubules with no obvious separation into halves at mid-line; tubules with no apparent orientation, no apparent internal openings, uniting with other tubules and opening into non-ciliated cavities joining with others forming paired, non-ciliated canals, moving anterolaterally, then dorsally, at level of anterior margin of vestimentum, then opening into basal area of dorsal groove of obturaculum by paired excretory pores.

Sexes separate; single external morphological difference—ciliated grooves anterior from paired male genital apertures, lacking in females; paired genital apertures of both sexes on dorsal surface at approximately same location, about 70% vestimental length; eggs just inside female aperture at germinal vesicle stage, about 78  $\mu\text{m}$  diameter, spherical except for slight distortion due to packing; sperm just inside genital aperture with elongate bodies, corkscrew-shaped, about 9  $\mu\text{m}$  long, 0.6  $\mu\text{m}$  diameter, tails about 9  $\mu\text{m}$  long; no spermatophores seen; sperm ducts with ridge of epithelium along length; no eggs or developing embryos or larvae found in tubes of either females or males; none found in dorsal cavity formed by overlapping vestimental wings.

Trophosome of many lobules with central lumina, well-vascularized, with vascular plexi and lacunae over surfaces;<sup>3</sup> blood vessels forming lumina

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<sup>3</sup> The following papers concerned with the trophosome of *Riftia pachyptila* have been submitted to Science, as of this writing: H. Fehlbeck, an account of enzymes possibly attributable to the trophosomal bacteria; G. Rau, data on <sup>13</sup>C to <sup>12</sup>C ratios pertaining to these bacteria; and C. Cavanaugh, S. Gardiner, M. Jones, H. Jannasch, and J. Waterbury, a description of and observations on these organisms.

from which capillaries ramify throughout lobular mass; "tissue" of trophosome actually close-packed bacteria; surface of trophosomal lobules with numerous fine pigment granules/spots; trophosome in intimate association with gonads and gonoducts (Fig. 2G); trophosome of most specimens with crystals of free elemental sulfur in "tissue"; trophosome present in juvenile as small as 1.44 mm total length (USNM 59961).

In smallest juvenile (USNM 59963), total length 0.75 mm, no mouth, no gut, no anus; setae in two rows on opisthosome identical to setae of adults but of smaller size.

*Color in life*.—Obturacular region: tentacles, red; obturaculum, whitish, occasionally with greenish tinge; dorsal groove with white margins, interior, pink; ventral ridge, white; splayed apical surfaces pink with dark red obturacular vessels near surface. Vestimental region: anterior dorsal margin with green suffusion; inner and outer surfaces of overlapped flaps, red; ciliated tracts of male, brown/green; ventrally united anterior nerve, green; separated nerves at level of ciliated field, white with lateral red lines; united posterior nerve, green; ventral ciliated field, dark red; papillae, beige against pinkish beige background. Trunk: beige to pink beige, with green line on anterior dorsal surface at junction with vestimentum. Opisthosome: pink/dark red.<sup>4</sup>

*Faunal associates*.—Other animals present with *Riftia* in the immediate vicinity of the geothermal vents include *Calyptogena magnifica* Boss and Turner (vesicomysid clam), *Bythograea thermydron* Williams (crab), a mytilid mussel, several shrimp, several limpet-like gastropods, a number of calanoid, cyclopoid, and harpacticoid copepods, at least six families of polychaetes, and a brotulid fish. Of these, the crab and the several shrimp appear to be predators on *Riftia*, based on direct observations (*vide* J. Childress).

*Feeding*.—The obturacular plume of *Riftia*, with its elaborate vascularization, would seem to be the most likely site for the uptake of at least small organic molecules. The extreme number of tentacles, each with up to 100 pairs of transverse intraepidermal vascular loops and the large cumulative surface of the vascularized pinnules (up to 100 pairs on each tentacle), comprise an admirable organ for molecular uptake. There is a possibility that similar uptake takes place across the body wall of the trunk, but nutrients would have to be carried in the water in the tube; due to the thickness of the tube wall, ruling out a diffusion across this wall, and the fact that such water could be renewed only during the occasional withdrawal of *Riftia* into its tube, this alternative seems much less likely. The trophosomal bacteria may also play a role in the nutrition of *Riftia*. The similarity of ratios of  $^{13}\text{C}$  to  $^{12}\text{C}$  in the trophosome (bacteria) and in the vestimental musculature

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<sup>4</sup> Color observations were made on specimens returned to the surface vessel laboratory, about two hours after collection; the worms probably were moribund at the time.

found by Rau (personal communication) suggests that *Riftia* may utilize the bacteria and/or their metabolites as a source of organic carbon.

**Comparisons.**—*Riftia pachyptila* is closely related to the recognized vestimentiferan species *Lamellibrachia barhami* Webb (1969a) and *L. luymesii* van der Land and Nørrevang (1975). The presence of an obturaculum with its associated tentacles basally fused to form tentacular lamellae (Figs. 1B, 2B), with the presumed excretory ducts on the anterodorsal margin of the vestimentum near the base of the obturaculum, the presence of the vestimentum with its dorsolateral flaps (Fig. 1B), with a ventral ciliated field set off by a bifurcation of the ventral nerve (Fig. 1E), with both female and male genital apertures opening on the posterodorsal surface of the vestimentum from an anterior extension of the trunk, with a trunk containing an extensive trophosome and primary longitudinal muscle of the "feather" type (Fig. 2F, G), and with neurular tubes in association with the ventral nerve (Figs. 3A, 4F), all leave no doubt as to this relationship. Unfortunately, there was no opportunity to compare the opisthosome of *Riftia* with those of either species of *Lamellibrachia*, for in the one case (van der Land and Nørrevang, 1975) the opisthosome was lost at the time of collection; in the other case (Webb, 1969a) a detailed description has yet to be recorded and this account leaves me with some doubt as to whether the opisthosome has actually been observed. I have had the opportunity to examine specimens of *L. barhami* deposited here by E. Barham (USNM 55162), comprising part of his original collection. In all specimens examined, the posterior ends, usually 1 mm or less in diameter, were either poorly preserved or had dried and were flattened against the inner surface of the tube; I was, thus, unable to identify an opisthosome in these specimens. I have also examined specimens of *L. barhami* collected by trawl by A. Carey, Oregon State University, 30 Oct 1967, at 1,400–1,600 m depth, at about 44°35.7'N, 125°11.0'W (in part, USNM 61103). The posterior ends of these specimens, also, appear to have been poorly preserved or to have dried so that confirmation of an opisthosome was not possible.

Of the differences so far observed in comparing *R. pachyptila* with the descriptions of both species of *Lamellibrachia* and with specimens of *L. barhami*, the following characters of *Riftia* are deemed to be of most importance. Obturacular region: Tentacular lamellae are free from one another for most of their length (Fig. 1D); tentacular lamellae arise perpendicularly from the obturaculum (Fig. 1D); there are no "tentacular sheaths" (Webb, 1969a; van der Land and Nørrevang, 1975, 1977); obturaculum comprises no less than 11% of the total length (Table 1). Vestimental region: Bears two separate and distinct external openings of the ducts from the presumed excretory organ(s); vestimentum may comprise from 7 to 22% of the total length of young or older adults (of greater than 50 mm total length) (Table 1). Tube: With one opening, nearly cylindrical, with very little tapering

Table 2.—Comparison of diagnostic characters of Lamellibrachiidae Webb and Riftiidae new family.

	Lamellibrachiidae	Riftiidae
Orientation of tentacular lamellae	Axial, parallel to obturaculum	At right angles to obturaculum
Tentacular sheaths	Present	Absent
Relative length of obturacular region	4% total length	10% total length
External opening(s) of excretory ducts	One	Two
Shape of tube	Tapered	Essentially cylindrical

toward the closed basal end (Fig. 1A). Taken as a whole these differences suggest that *Riftia* should be separated from *Lamellibrachia* at the familial level (Table 2).

Although the arguments of van der Land and Nørrevang (1975, 1977) are persuasive and their points are well-taken, at the present time, I must consider the basic regionation of *Lamellibrachia* and *Riftia* as indicating a close relationship with the frenulate Pogonophora. The presence of demonstrable coelomic cavities in the first and second regions of the latter and the absence of such in *Lamellibrachia* and *Riftia* might well be a consequence of the development of the solid obturaculum and the heavy muscularization of the vestimentum. Other differences, e.g., the vestimental wings, the presence of the trophosome, neurular tubes, and multicellular pinnules, the absence of spermatophores, the medial dorsoventral mesentery of the opisthosome, the tube morphology, in my present view, might be accommodated by considering them to discriminate between subphyla. While this decision might appear to be somewhat frivolous or gratuitous, I feel that it best summarizes my view of the relationship of *Riftia* and *Lamellibrachia*, with respect to the other pogonophorans, i.e., it admits the unifying character of the basic body plan of four regions, but emphasizes the exceptional and unique differentiating characters listed above. Further studies of *Riftia* and *Lamellibrachia* may temper my judgement in this respect, but for now, I here propose two subphyla for the phylum Pogonophora: **Obturata** new subphylum (from Latin, *obturo* (close up, stop up), in reference to the operculum-like function of the obturaculum of *Lamellibrachia* and *Riftia*); and **Perviata** new subphylum (from Latin, *pervius* (affording a passage, open, penetrable), in reference to the lack of an operculum-like structure in the remaining pogonophorans).

Concerning the relationships of the Pogonophora I concur with van der Land and Nørrevang (1975, 1977), Southward (1975a, b), and George (1973)



in considering the phylum to be most closely related to the phylum Annelida. The opisthosome, with its repeated similar segments provided with chitinous setae, as well as the morphology of the latter, is the single most compelling feature contributing to my conclusion.

There is no question that all vestimentiferan specimens from the various geothermal vents of the Galápagos Rift are *Riftia pachyptila*. I am less certain of the identity of the single specimen available from the East Pacific Rise; superficially there is little difference between this specimen and those from the Galápagos Rift, some 3,400 km distant. So far I have not chosen to dissect this single specimen; more material should be available from the Rise area in the coming year, when a detailed examination should shed light on the taxonomic status of the northern specimens. The relatively large obturacular region (Table 1, USNM 59964) suggests that a different species may be present there, but for now, I must conclude that *Riftia* is a monospecific genus.

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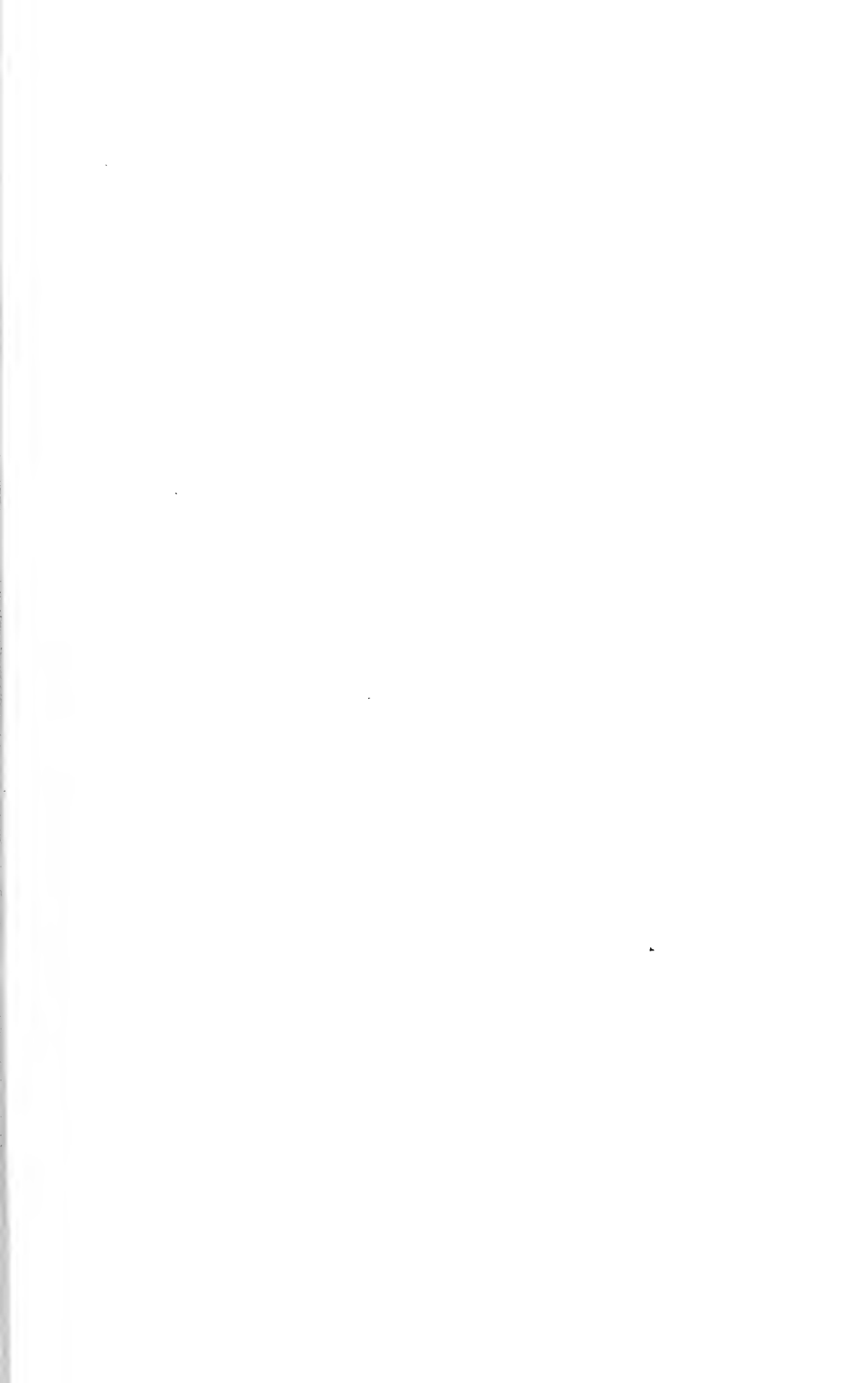
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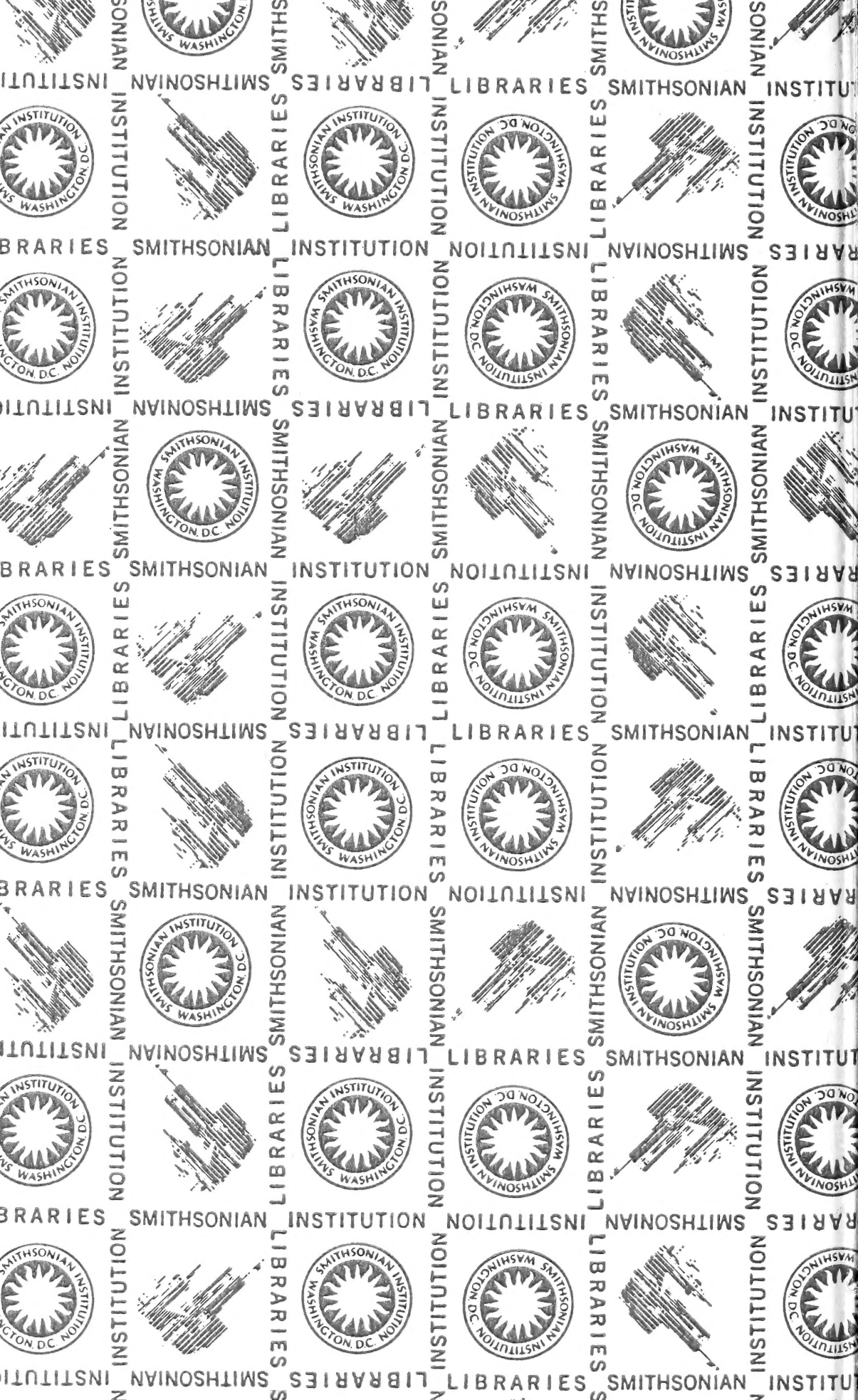
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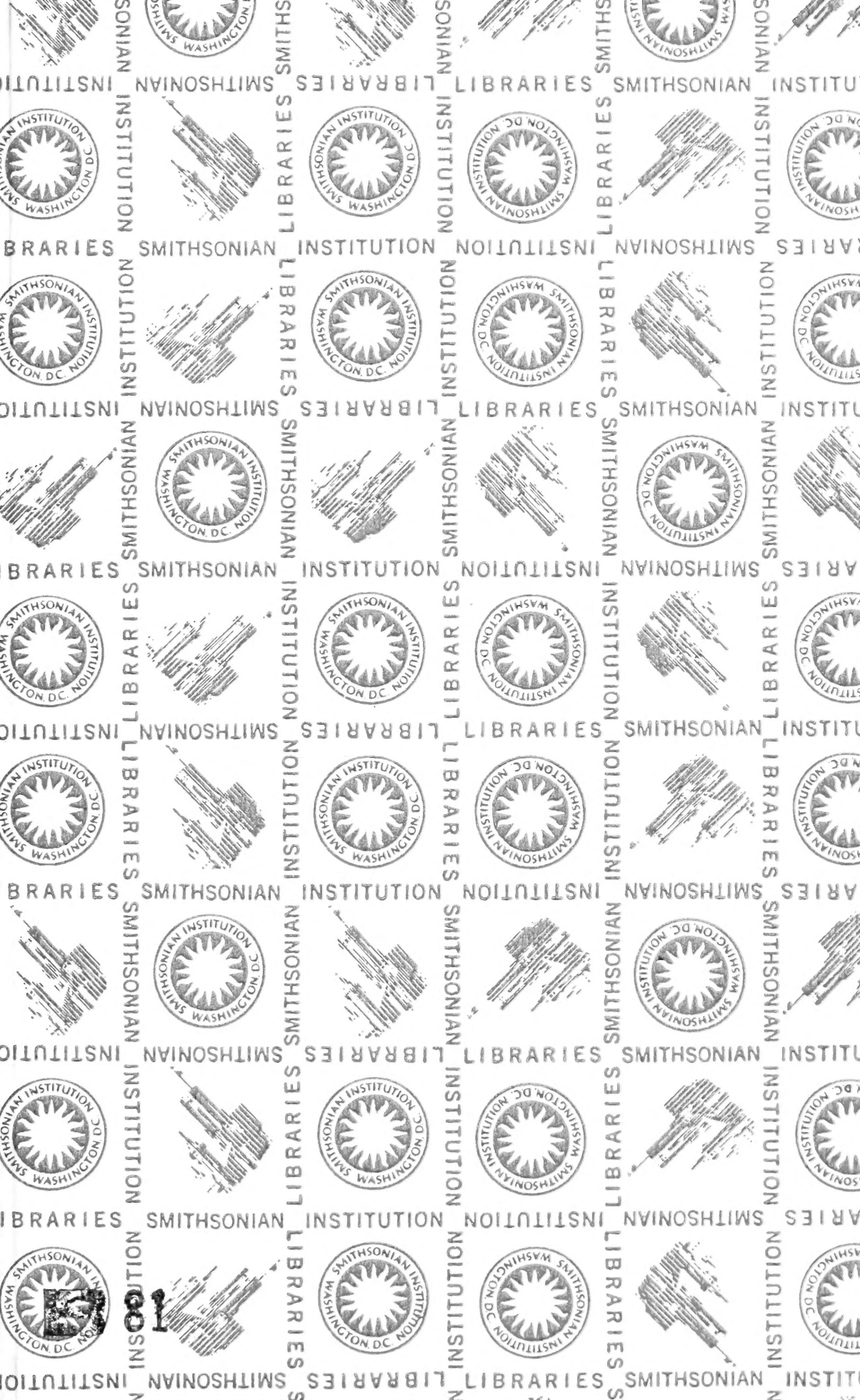












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